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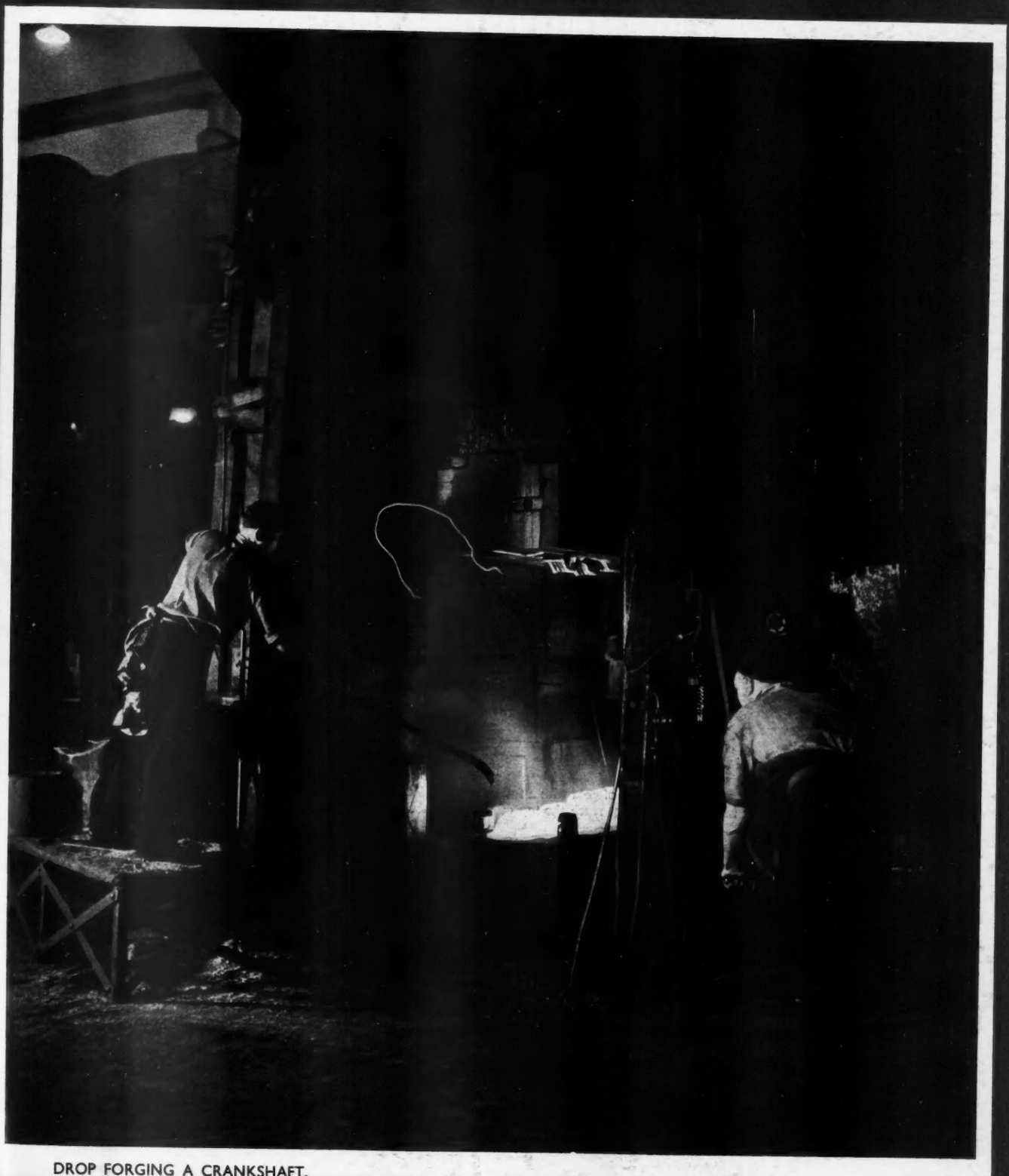
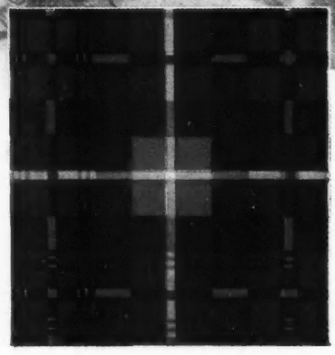


DROP FORGING A CRANKSHAFT.

Famous Scottish Names...

Farquharson



Farquharsons claim descent from the ancient Thanes and Earls of Fife, one of whom was the MacDuff who defeated Macbeth. For valiant service in his cause King Robert the Bruce made Shaw MacDuff the Farquharson chief, hereditary chamberlain of the royal lands of Braemar, which adjoined the clan's own country. From the earliest times Upper Deeside has been a favourite resort of royalty. Just as Queen Victoria and later sovereigns make their way there every year, so the early Scottish Kings are said to have periodically visited this land in ancient times. The great Highland Gathering still held each autumn is said to have been founded by the mighty Malcolm Canmore, who offered a prize of a purse of gold with a full suit of Highland dress and arms to the man who could first reach the top of Craig Crynoch.

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ENGINEERING.

SEDIMENT PROBLEMS ON IRRIGATION PROJECTS IN THE UNITED STATES.

By E. W. LANE.*

THIS article describes briefly the problems of sedimentation on irrigation projects, particularly in the United States, and discusses the means of solving these problems. Sediment has been defined as the fragmental material transported by, suspended in, or deposited by water or air, or accumulated in beds by other natural agents; any detrital accumulation such as loess. Sediment problems in irrigation, therefore, involve the movement or deposition of soil material in or by water. In general, the problems fall into six classes—(1) the filling of reservoirs, (2) scour or deposit in canals, (3) control of sediment entering canals, (4) enlargement of streams or drains, (5) aggrading of streams, and (6) degradation of stream beds below dams.

FIG. 1. ORIGINAL CONDITION OF FIVE MILE CREEK, WYOMING.

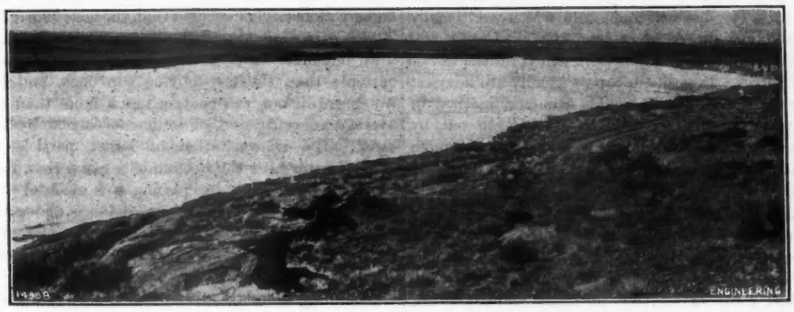

FIG. 2. PRESENT CONDITION OF CREEK.

FILLING OF RESERVOIRS.

The filling of reservoirs with sediment forms probably the most important problem on irrigation projects in the United States. The loss in the United States alone, due to the filling of reservoirs, was estimated in 1947 by the United States Soil Conservation Service as 50,000,000 dols. per year. The principal reason why greater effort is not made to reduce this loss is that most of the reservoirs are relatively young and therefore only slightly filled with sediment so that the inconvenience due to the filling is still relatively small. There are several ways by which the rate of deposition of sediment in reservoirs may be reduced. Apart from the costs involved, the best method of keeping sediment out of reservoirs is by keeping it in its original place, either on the watershed by soil conservation measures (which reduce the rate of erosion of the land surface) or in the stream channels of the drainage area. Under favourable conditions, much can be accomplished along these lines, although, in many cases, the cost is prohibitive. In general, the best results can be obtained under conditions of low relief, scour-resistant soil and of sufficient rainfall to produce a rapid growth of protective vegetation.

Scouring of reservoirs is moderately effective in only a few cases. The conditions required for success are narrow, steep reservoirs filled with comparatively fine sediment which can be flushed out by a relatively large flow of water when the reservoirs are practically empty. Considerable attention has also been given to the possible discharge of the sediment by density currents which carry sediment along the bottom of the reservoir beneath the clear water stored in it. Although some benefit may be secured by this method, sufficient knowledge of density currents is not yet available to permit an accurate appraisal of this method.

Sediment is deposited roughly uniformly over the bed of the reservoir and this has both advantages and disadvantages. If the sediment filled the reservoir as water does, preserving a level surface, it would first fill below the level of the outlets, where it would cause no trouble as it would not reduce the effective capacity of the reservoir, but depositing on the slopes produces some reduction of capacity at nearly all levels of the reservoir, beginning as soon as water is stored in the reservoir. The uniform filling of the channels and often of the valley with sediment upstream of the reservoir, to higher levels than the water being stored in the basin, destroys the arability of considerable areas of land upstream from the reservoir and will, in time, destroy improvements which are some distance above the reservoir level. Since some fall of the stream will be necessary to carry the sediment from the upper to the lower end of a reservoir, when it is filled with sediment at the downstream end to the spillway level, it will be filled at the upper end of the reservoir to a higher level. Therefore, practically all reservoirs will eventually fill to above spillway level at the upstream end.

Because all reservoirs will fill up eventually, it is very important that accurate estimates should be made of how rapidly they will be filled before construction is begun, in order that none will fill too rapidly to justify their construction. To make these predictions, it is necessary to know, in addition to the storage capacity of the basin, (1) the amount of sediment brought down by the stream, (2) the density of the sediment which will be deposited in the basin, (3) the proportion of the sediment deposited above spillway level, and (4) the proportion of the inflowing sediment that is deposited in the basin.

The amount of sediment brought down to a reservoir can best be obtained by measuring the sediment flow by frequent sampling over a series of years. Considerable study has been given to this sampling and, if carried out over a sufficiently long period, reasonably accurate predictions can be made, provided conditions in the watershed do not change. The density of the sediment depends on the particle size of the material and the extent to which the deposited sediment is permitted to dry out. Because few data are available, the proportion of sediment deposited above spillway level is commonly ignored, but this is on the safe side

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SEDIMENT PROBLEMS ON IRRIGATION PROJECTS.

FIG. 3. ENLARGED CHANNELS OF SUNSHINE CREEK, WYOMING.

FIG. 4. HIGH BANK DUE TO INCREASED FLOW, SUNSHINE CREEK.

when estimating a rate of filling. The advantages of the decreased rate of filling resulting from filling above spillway level are offset, however, by the damages which result from it. Little quantitative data is available on the proportion of the inflowing sediment that is retained in the reservoir, or the "trap efficiency" of the reservoir; for large reservoirs, until they are nearly full, this efficiency is usually close to 100 per cent. The trap efficiency increases with the size of the sediment and, for sand of larger sizes, approaches close to 100 per cent. After a reservoir is put into service, periodic surveys are usually required to check the rate of fill and the remaining water storage to ensure the most efficient use of the water.

SCOUR AND DEPOSIT IN CANALS.

Scour or deposit in the irrigation canals is another important aspect of sediment problems in the United States. This is generally termed the "stable channel" problem, a stable channel being a canal which does not scour or fill with sediment to an undesirable extent. Unstable channels can be divided into three classes: (1) those where scour but no depositing occurs; (2) those in which depositing occurs, but which do not scour; and (3) those in which both scour and depositing occur. The first class of channel usually carries water with little or no sediment, the scour depending on the tractive force or shear around the periphery of the channel. Scour was once thought to be related to mean canal velocity, but it has long been known that when built in the same material, large canals could carry water at a higher velocity without scouring, than small ones. This problem of scour in canals has recently been the subject of an extensive study by the United States Bureau of Reclamation, and new methods of canal design have been developed, on the basis of tractive force or shear distribution.

The second class of channel in which depositing, but not scour, occurs is found where heavy sediment loads are transported in canals with banks and bed of material which are highly resistant to scour. The design of these canals depends on their sediment capacity, but, although considerable progress has been made in recent years in improving the methods of computing this capacity of canals, this phase of the problem is not yet adequately solved. The third class of channels, which both scour and deposit, also carry heavy sediment loads, but differ from the second class in that they are constructed in easily erodible material. In this case, the problem is to so choose the form of the channel that the heavy sediment load will be carried without scouring the banks. It is probable that the fine material carried in suspension in the water tends to make the bank more resistant to scour. This type of problem has been extensively dealt with in India, and successful methods of handling it have been developed there. Unfortunately, the formulae developed frequently involve factors which have been learned by experience alone and which are not readily applied by one lacking this experience.

The depositing of sediment in canals is, in many cases, a very troublesome feature and it is often the most costly item of maintenance. Before the construction of the Hoover Dam, one large undertaking on the lower Colorado River, paid over a million dollars a year to keep its canals cleaned out. Where heavy deposits have occurred, a problem arises in finding dumping grounds for the excavated material.

CONTROL OF SEDIMENT SUPPLIED TO CANALS.

When a canal of satisfactory shape and slope, capable of carrying the required sediment load, cannot be obtained, it is necessary to reduce the amount of sediment which will be supplied to the canal. A great variety of devices have been developed to accomplish this and the design problem in this case includes the selection of the device best fitted for the prevailing conditions. One of the most widely used methods of reducing the sediment taken into irrigation canals is to locate the intake on the outside bend of the stream. Structures for reducing the sediment can be divided into two classes: (1) excluders, which are located just upstream from the canal head gates, so preventing the sediment from entering the canal, and (2) extractors, ejectors or eliminators which are usually located just downstream from the headworks and which extract or eject the sediment from the canals themselves. Deposits in canals usually are heaviest near their upper ends, and a common method of removing such deposits is to scour them out by allowing the water to escape from the canal through a sluice located some distance downstream from the headworks. This is sometimes done continuously, using part of the canal flow, and in other cases by occasionally flushing out the deposited section using the entire canal flow.

The design of excluders or extractors has been studied most extensively in India and Pakistan. Other work has been done in many countries, however, and the following notes are based on a study of all available literature. Practically all of the devices used involve one or more of eleven types of action. These types of action are as follow: (1) the slot, (2) the step, (3) deflecting vanes, (4) drawing-off of slower moving currents, (5) separation of top and bottom water, (6) the skimming weir, (7) grillage, (8) curved currents, (9) settling basins, (10) sluice, and (11) still pond. Of these types, numbers 1, 5, 8, 9, 10, and 11 are most frequently used. In some instances, two or more of these actions are combined in a single installation. The slot is a depressed trough or channel across the bottom of a canal into which the sediment drops as it passes down the canal, and from which it is washed out by a flow of water. The step is related to both the slot and the settling basin. In it, the bottom of the canal is gradually depressed, forming a small basin, at the downstream end of which the bottom rises abruptly to the normal canal invert level again. A gate is placed in the canal bank just upstream from the step through which the sediment deposited in the basin can be flushed out. Material rolling along the bed, or carried in the water near the channel bottom, can be deflected away from an opening through which the water for irrigation is drawn by suitably located vanes. Drawing-off the slower moving currents is another means of removing the sediment from irrigation water, for these currents are usually at the bottom of the channel where most of the sediment is carried and are more easily deflected than the faster currents. A sluice in the side of the channel will therefore draw out more water from the slow-moving bottom currents than the fast-moving top ones, and the water drawn out will contain much more than the average concentration of sediment carried by the canal. The concentration of larger particles is much greater near the bottom of a canal than near the surface so that, by placing a horizontal diaphragm across the canal some distance above the bottom and wasting the water which passes beneath the diaphragm, most of the coarse sediment can usually be taken out with this water.

Skimming weirs are often used to keep sediment-laden water out of canals by allowing the top water to pass into the canal, while the remainder of the water, with its heavier sediment load, continues down the stream. Coarse materials, such as cobbles or boulders, can be separated out by drawing the water from the bottom of the stream through a grillage of bars which allows them to roll on down the stream. The action of curved currents is the same as that involved in placing the canal intake at the outside of the bend, as previously mentioned. Settling basins are enlargements of the channel in which the velocity and the turbulence

SEDIMENT PROBLEMS IN THE UNITED STATES.

FIG. 5. DEGRADATION AT FORT SUMNER DAM, NEW MEXICO.

FIG. 6. WEIR ON COLORADO RIVER CAUSED BY DEGRADATION DUE TO A DAM 55 MILES UPSTREAM.

are reduced, and where the sediment settles to the bottom to be flushed or pumped out. This type of basin will remove finer sediment than any of the others. Theoretically, as much sediment as desired can be removed from the water in a settling basin, but it is rarely practicable for irrigation purposes to remove a high percentage of particles much smaller than sand (or below about 0·06 mm. in diameter). None of the other devices previously discussed will separate out material much finer than sand.

Sluices are used in both excluders and extractors. When used as an excluder, the sluice is usually placed in the dam adjacent to the ports through which the water enters the canal. The sluices are commonly large enough to take the low-water flow of the stream, and when they are opened, the water flows through them at a sufficiently high velocity to remove the material deposited in front of the canal intake. When used as an extractor, they are placed in the canal some distance downstream from the intake, with a return channel to the supply stream. By opening the sluice, the water in the canal is speeded up and any sediment deposited in the canal is flushed through the sluice and back into the stream.

A still pond is formed by constructing a wall extending upstream from the dam to form an area of low-velocity water upstream from the canal intake and in which much of the sediment in the water approaching the canal is deposited. A sluice, placed in the dam at the downstream end of the pond, is opened periodically to cause high-velocity currents which flush the deposited sediment back into the stream. The wall confines the current to make its scouring action more effective. All of the eleven devices require some water for their operation, but some require more than others and the type of device applicable is often limited by the amount of surplus water available. In India and Pakistan, where sediment loads are high, the sediment is often distributed among the canal branches using devices somewhat similar to those mentioned above. Hydraulic models have been used extensively to predict the action of excluders and extractors; although the model theory for the sediment movement and deposition is not well established, surprisingly good results have been obtained by such model studies. While sediment in the irrigation canals may cause considerable difficulty, in some circumstances it can be a great benefit by improving the land by fertilising or otherwise improving the texture of the soil.

ENLARGEMENT OF STREAMS USED AS DRAINS OR SUPPLY CHANNELS.

Another troublesome problem found on some irrigation projects in the United States is the enlargement of the streams that are used as drains to carry off the waste or seepage water. Such problems are likely to occur in irrigated regions where there is a considerable natural fall. The size and slope of these streams was originally suitable to the small flows carried before irrigation was introduced, but the addition of the extra flow of water causes scouring that deepens the beds. If the material through which they flow is easily eroded, large gulleys are formed, possibly destroying valuable land and structures along the stream, and much sediment may be carried downstream to be deposited elsewhere. One solution to this problem is to build over-fall dams at intervals along the stream to reduce the gradient sufficiently that scouring conditions are not produced. However, as these dams must be strong enough to withstand the occasional large flood which may occur in the stream, they are apt to be too expensive. Alternatively, the waste flow may be taken in a separate canal with paved sides and invert or with drop structures at intervals in which the energy can be dissipated without scouring the canals. Since these structures will not have to carry the full flood, they can be much cheaper. In some cases, riprap on the banks and bed will accomplish the purpose, but often the fall is too steep for this method of protection.

Five Mile Creek, on the Bureau of Reclamation's Riverton Project in Wyoming, is an example of this type of difficulty. This stream has a fall of about 22 ft. per mile and sometimes carries as much as 300 cusecs of seepage and waste water. Fig. 1, on page 1, shows the nature of this creek in its original condition and Fig. 2, on the same page, illustrates a section of it which has become greatly enlarged. Were it not for the fact that rock ledges are encountered in the banks and bed at intervals, much worse conditions would have resulted. Measurements show that about two million tons of soil per year are removed from the bed and banks of this stream and at times the rate of removal reaches as much as 20,000 tons per day. This stream discharges into Boysen Reservoir into which the sediment is deposited and, unfortunately, no practicable way of remedying this situation at reasonable expense has yet been devised.

A somewhat similar difficulty was encountered on the Gering Drain on the North Platte Project in Nebraska. Here a small drain was constructed to carry off the waste and seepage water from the Gering Valley. The material through which the drain runs is easily eroded, and the slope of the valley was too steep, causing the drain to enlarge rapidly. The enlargement of the channel causes storm rainfall to run off rapidly, accentuating still further the scour, and has caused the loss of numerous bridges and much valuable farm land. A similar condition sometimes results when natural streams are used for supply channels. For example, water is brought into Sunshine Creek in Wyoming from another watershed and stored in a reservoir from which it is released when the supply to the irrigated land downstream is inadequate. The stream below the reservoir runs through easily erodible material and has a steep slope and the flow in the stream is now so much larger than before, that the bed is deepening and widening, as shown in Figs. 3 and 4, opposite. Trouble has also been experienced in streams from the addition of water from other watersheds, where the beds are composed of cobbles and boulders.

AGGRADING STREAMS.

The problem of aggrading streams can be illustrated by describing the situation in the Middle Rio Grande Valley in New Mexico. Here the bed of the river has been rising and is now above the street level of the business section of Albuquerque, a city of about 100,000 population and one of the fastest growing cities in the United States. Aggradation of the river bed has resulted from four causes: (1) upstream from Albuquerque, where the Rio Grande emerges from the mountains, a large volume of relatively clear water is diverted for irrigation, leaving less water to carry off the more heavily sediment-laden water from the plains area further downstream; (2) the sediment movement from the plains has been increased by over-grazing with resulting sheet erosion and gullying; (3) irrigation water is diverted from the river in the Middle Valley, and the sediment in this water is partially removed and returned to the stream; and (4) a number of low irrigation diversion dams have been constructed in the river, and experience has shown that, under the conditions in this stream, such dams raise the river beds for long distances upstream. As a result

of this increase of sediment load, combined with a reduction in the water available to carry it and the obstruction of the channels by the dams, this section of the river bed is rising at a rate of about 1 in. per year. In turn, the rise of the river bed is causing a rise in the ground-water level in the irrigated areas that threatens to waterlog the land, as well as providing a flood threat to Albuquerque and other towns along the river's course. The solution to this urgent problem is combined flood control and sediment-storage reservoirs on two of the most heavily sediment-laden streams of the valley, in addition to extensive improvements of the stream channel. This work is an expensive undertaking, but is necessary if the valley is to be saved.

DEGRADATION BELOW DAMS.

When a dam constructed on a stream stops the movement of coarse sediment, the water passing the dam picks up a new load of sediment from the bed downstream, thus causing a lowering or "degrading" of the bed. If the movable bed material is deep and of comparatively uniform size, the bed may be lowered considerably. This action has been known for more than a half century, but only in about the last 20 years has it been widely recognised. If the dams are not designed for this lowering, they may be badly damaged. The Fort Sumner Dam on the Pecos River in New Mexico was so seriously threatened that an entirely new dam had to be built. At the time of construction of the first dam, the bed of the river was roughly at the level of the apron which is now about 9 ft. above the river bed. Fig. 5, on page 3, shows the condition of the spillway with the apron high above the present river-bed level. The degradation may extend for considerable distances downstream and cause trouble to structures there. Fig. 6, also on page 3, shows a rock-fill weir on the Colorado River built to raise the water so as to maintain a diversion into an irrigation canal at a point where degradation has been caused by a dam 55 miles upstream.

Degradation takes place more rapidly on steep streams having fine non-coherent bed material. The lowering of the bed level occurs first near the dam and gradually extends downstream, continuing until a rock ledge downstream is uncovered which stops further lowering. The water removes the finer bed material, leaving something like a paving on the stream bed, so reducing the rate of movement. Although not yet observed, it is probable that heavy floods in the future will remove this paving to set up a new cycle of lowering. Approximate estimates can be made of the extent of the lowering which will occur, but this is laborious.

Since sediments composed of particles of varying sizes act very differently, it is necessary to know the particle sizes and their distribution if accurate predictions are to be made. In recent years, considerable effort has been applied to devising apparatus and procedures for the accurate measurement of the sediment load in streams and for determining the particle sizes involved.

From the foregoing information, it is evident that sediment problems are often severe and the cause of much expense. The solution of many of these difficulties has not yet been found, but by careful and intelligent planning they may often be avoided and, in most instances, the difficulties resulting from sedimentation can be reduced. Most irrigation projects are comparatively young, and the earliest projects in the United States generally involved clear water, but streams carrying more sediment are now being developed, so that the resulting problems are likely to be more troublesome. Then every device and artifice will have to be employed.

The writer wishes to acknowledge the valuable suggestions received in the preparation of this article from W. M. Borland, K. B. Schroeder, E. J. Carlson, and D. J. Hebert, all of the Bureau of Reclamation's engineering offices in Denver, Colorado.

LITERATURE.

Charbons Activés (Adsorption des Gaz et des Vapeurs).

By PROFESSOR C. COURTY. Gauthier-Villars, 55 Quai des Grands-Augustins, Paris (6e). [Price 4,500 francs.]

ONE of the most remarkable properties of charcoal is its power of absorbing many times its own volume of a gas. This absorptive capacity is a surface phenomenon and depends mainly upon the porosity of the specimen, which can be developed by appropriate physical or chemical treatment. One cm.^{3} of carbon thus "activated" may possess a surface area as great as 1,000 sq. m. and a surface-to-mass ratio of the order of $2 \cdot 10^7$ cm.^{2} gm.$^{-1}$

Though Professor Courty's treatise is concerned primarily with the properties and applications of activated carbon, it is largely occupied with a scientific study of adsorption—the physical process responsible for the superficial fixation of gases upon solids. In fact, after some brief general introductory remarks, rather more than 200 pages are devoted to the theoretical aspects of adsorption. These include a detailed discussion of the classical theories and modifications of them in the light of quantum mechanics, the thermodynamical interpretation of heats of adsorption, the effect of temperature, quantity adsorbed, nature of adsorber and adsorbent, the influence of Van der Waals forces, together with confirmatory data from experiments on activated carbon and the kinetics of adsorption. Chapter VI deals with the theory of, and experimental work relating to, the simultaneous adsorption of mixtures of gases and vapours by activated carbon. This is of interest because, being a selective effect, it can be applied to secure the partial separation of one gas from another. In practice, dynamical adsorption from a current of gas is more frequently encountered than statical adsorption from an enclosed volume of gas, and this is fully treated in a lengthy chapter.

One of the most important applications of this is to the gas mask, and a detailed discussion of the factors (such as temperature, volume, thickness and granulation of the active material) determining the time of effective protection against various toxic gases, is followed by a description of methods for testing the efficacy of gas masks. Although no chemical action is generally involved in adsorption, the process is only partially reversible, for part of the adsorbed gas is so tenaciously retained that it is practically impossible to recover it. The difficulties arising in the study of desorption and retentivity are explained in Chapter VIII and, despite access to hitherto unpublished measurements by Ackermann, the need for more precisely controlled experimental investigation is stressed. Considerable difficulty is also experienced in determining the porosity and effective surface area of samples of activated carbon and, though several of the methods described in the following chapter show considerable ingenuity, they are not always wholly reliable. Moreover, recent work has indicated that, under certain circumstances, some chemical action may accompany the normal adsorption process—carbon, for instance, oxidises slowly on exposure to the air, particularly in the presence of moisture—and a comprehensive outline of the present state of knowledge concerning this is given in Chapter X.

The concluding chapter is occupied by a consideration of the qualities that must be possessed by an activated carbon if it is to function satisfactorily as an adsorber of gases and vapours. Essential numerical data for comparing carbons from 31 different sources are collected together and presented in tabular form. This is only one among some 150 tables which form a valuable feature of the work. The 563 entries in the bibliography reveal the extent of the subject even when restricted to the adsorption of gases by a single solid adsorber, leaving aside the adsorption of liquids and solids upon one another. The size of Professor Courty's book affords evidence of the thorough manner in which he has presented this particular significant aspect of it. Some space might have been saved by omitting certain details which are readily available elsewhere, as, for instance, much of the section on surface tension. One of the few misprints noted is the incorrect value of the conversion factor on page 375.

Power Cables: Their Design and Installation.

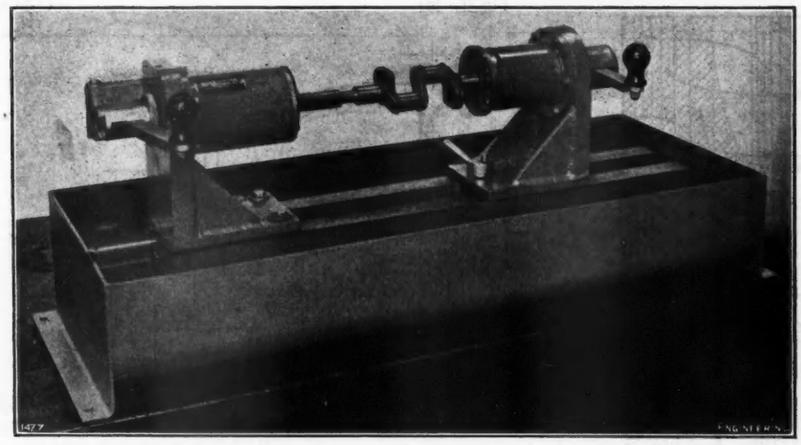
By C. C. BARNES, A.M.I.E.E., A.I.I.A. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 35s. net.]

THE continuing rise in the voltages used for electric-power transmission has imposed a number of difficult problems on designers and manufacturers of underground cables, many of which have already led to some interesting solutions. In this development British engineers have played a notable role, partly because they have been pioneers in this field since the days of Ferranti and partly because conditions in this country have tended to exalt the underground cable above the overhead line. It is therefore fitting that a volume on power cables should be included in a series of monographs on electrical engineering, especially as there are a number of papers on the subject in more than one language, the contents of which badly need co-ordinating.

We are told that the object of Mr. Barnes' book is to provide a review of the basic design and engineering data used by engineers when dealing with inquiries for power cables. Manufacturing processes are also briefly discussed, and the factors associated with installation, maintenance and fault location are reviewed. Cable design and the requirements necessary for its fulfilment are briefly dealt with. A chapter entitled "Core Identification and the Assembly of Multicore Cables" follows. This is not a very happy description, since its contents include a number of other subjects. The mechanical protection of the lead-cased cable is then discussed, while other chapters deal with testing requirements, technical characteristics, the calculation of dimensions, weights and current ratings. Oil-filled and gas-pressure super-voltage cables are described in a chapter which is unduly short considering the importance of the subject; and then details are given regarding manufacturing methods, installation, jointing and terminations, fault location, modern submarine cables, high-voltage direct-current transmission and care and maintenance. Finally, there are no less than 28 appendices containing much tabular matter on cables, as well as on metal price variations and other information. There is also an extensive bibliography and a short index.

It will therefore be gathered that a great deal of information has been compressed into some 270 pages, and that in so doing Mr. Barnes has covered a wide field. Nevertheless, the result is a little disappointing. This would appear to be due, in part, to the poor arrangement of the material. In writing a book of this kind it is wise to follow certain historic advice by beginning at the beginning and going on to the end. Applying this to cable manufacture, it would seem logical to start with the operating conditions that have to be met, to describe the designs that have been devised to meet those conditions, the materials used to implement those designs and the manufacturing methods that have been adopted to combine the two into the finished product. Information on testing and installation procedure would naturally follow with concluding chapters on fault location and maintenance. As it is, information relating to various parts of one or other of these main subjects is scattered throughout the book. To take one example. A section on drying and impregnating

PERMANENT-MAGNET CRACK DETECTOR.



(part of the manufacturing process) appears as early as page 29, in a chapter entitled core identification, although the subject is again dealt with on page 136, in its proper place in the chapter on manufacture. Again, the information given is sometimes not well balanced. For instance, full details with illustrations are published of a submarine cable-laying operation off the Isle of Wight, but much less space than the subject deserves is devoted to super-voltage cables, and the information given about the extent to which they are used is meagre and relegated to an appendix. The appendix giving definitions of certain terms used in cable technology might well be extended, even if certain others, the information in which can be found elsewhere, were omitted.

These defects, however, must not be allowed to conceal the fact that this is a valuable book. It enables the present state of the art to be appreciated and it will form an excellent introduction to further study of the subject.

MOISTURE CONTENTS OF TIMBERS FOR VARIOUS PURPOSES.—The Kiln Owners' Association have issued over 6,000 copies of a chart entitled "The Intelligent Use of Timber" to various local authorities, architects and firms; further copies may be obtained from the offices of the Association, 15, New Bridge-street, London, E.C.4. The chart is reproduced by permission of the Department of Industrial and Scientific Research. The main diagram shows, against the use to which an average timber is to be put, the desirable moisture content expressed as a percentage, and the corresponding relative humidity of the air at 60 deg. F., also expressed as a percentage. A second diagram shows the tangential and radial shrinkage in inches per foot of average timber against the moisture content per cent.; for example, a reduction in the moisture content from 27 to 2 per cent. is indicated as resulting in a tangential shrinkage of 1 in. per foot.

AN ELECTRODE COMPARATOR FOR MILD STEEL.—The British Welding Research Association, 29, Park-crescent, London, W.1, have produced a comparator which will assist in the selection of an electrode for the welding of mild steel. It is in the form of a slide rule. By setting the slide of this comparator to the welding position to be used and to the type of deposit required, details of which are given in a table on the comparator, the correct electrode specification and the makers name can be read off on the back of the rule. Alternatively it can be used in reverse by starting with the electrode specification and reading off the number of the B.S. 1719 classification, the coating, the position of welding, the current required, the correct voltage and the electrode polarity. The nearest American Welding Society electrode number is also given. Two other tables are printed on the comparator; one of these illustrates the welding positions, and the limits of slope and rotation, and the other gives the welding data for manual operation, including the material gauge, the current, the electrode size and the cable size. All the classified electrodes of 12 s.w.g. and over, shown in the latter table, conform to B.S.S. 639.

A PERMANENT-MAGNET CRACK DETECTOR.

By J. W. WALLEY, A.R.T.C.S.

THIS article describes a new design of magnetic crack detector which has recently been developed in the Research Department of Metropolitan-Vickers Electrical Company, Limited, Manchester. It is intended for the rapid handling of components which are being examined for transverse faults. Simplicity in design has resulted in an easily manufactured unit, largely due to the use of a permanent magnet for magnetising the component instead of the more conventional electric current windings.

At the present time, the majority of engineers are aware of the value to the engineering industry of magnetic inspection of ferrous components for surface cracks. These cracks are most important, since the stress in a highly stressed component is greatest at the surface and a minute crack may grow with time into a complete fracture. Fortunately, this type of component is nearly always made of an alloy of iron; thus the magnetic method of crack detection can be employed. This method is the most useful of the available methods of detecting surface cracks in ferrous materials. It is not surprising, therefore, that during the past few years there has been an increase in the range of magnetic crack-detection machines available to users, and that the design of existing types has been improved.

Nearly all the magnetic methods of fault detection are based on the fact that the presence of a crack or flaw in the magnetised material causes a field distortion or flux ripple which is localised at the position of the fault. This distortion will be greatest when the magnetising field is so directed that it crosses the fault at a right angle. It is also important to ensure that the strength of the magnetising field is sufficient to deal with the size and the material of the component. Hence the magnetic field must be correct in both direction and strength. To detect the field distortions which result from the presence of faults, use is made of a magnetic fluid consisting of a thin oil in which fine particles of iron oxide are suspended. When the fluid is applied to the surface of a magnetised component, particles near a fault are attracted by the local field distortion to form a ridge of particles along the line of the fault, and thus to indicate its presence. A good colour contrast between the particle formations and the component surface is essential. Black fluid shows up best on brightly machined surfaces, while for dark backgrounds either red or white magnetic fluid may be used.

The new detector, as will be seen from the accompanying illustration, is rather similar in arrangement to a small lathe. It consists of a sheet-steel drip tray which is surmounted by a steel bedplate. This bedplate carries a fixed magnet head and a sliding spring-loaded head. The magnet head, which is at the left-hand end, is a hollow cylinder and contains the permanent magnet, which is made of a modern high-energy material. The sliding head at the right-hand end can be moved along the bedplate and locked in a suitable position. This new design embodies a spring-loaded faceplate, which provides sufficient end pressure to hold the component under test, the pressure itself being controlled by a ball handle, as shown in the illustration.

The permanent magnet is cylindrical and may be moved by means of the ball handle from a short-circuited or "off" position to a magnetising or "on" position. This operation renders the magnet part of a series circuit comprising the front magnet pole-piece, the left-hand faceplate, the component under test, the right-hand faceplate, the sliding head, the bedplate, the fixed head and the back magnet pole-piece, so that the component becomes longitudinally magnetised. Thus the machine is particularly suitable for testing parts used under stress conditions which are likely to cause transverse cracks, e.g. car steering gear components, king-pins and stub-axles.

The magnetic fluid is contained in a sump at the front of the machine and is applied by means of an aluminium ladle which also acts as a stirrer. An important feature of this arrangement is that the fluid may be poured over the component with the magnet in the "on" position, i.e., during magnetisation, thus obtaining maximum sensitivity. This is not permissible with immersion-bath machines, which rely on residual magnetisation for transverse-fault detection.

The new machine is designed for testing ferrous components up to 18 in. long and with a periphery up to about 8 in. The faceplates are 4 in. in diameter and can thus accommodate irregularly-shaped components such as those with ends on different centres. Both faceplates are covered by copper-braid strips, $\frac{1}{4}$ in. thick, which are easily replaced when worn. In future models it is hoped to incorporate two magnets in order to be able to test longer components.

As regards operation, the sliding head can be set to suit the length of the component in a few seconds, and, for production testing, one setting is of course sufficient for each batch of components. Loading the machine is a simple operation. The right-hand lever is pressed, a component inserted and the lever released. The component is then held entirely by spring pressure between the faceplates and the maximum component surface area is exposed to the action of the magnet fluid. The left-hand lever is moved to the right, bringing the magnet "on," and the component is flooded with magnetic fluid. When the magnet has been switched off, the component may be removed for inspection by releasing the spring pressure.

As stated above, the permanent-magnet machine provides longitudinal magnetisation only. It can, however, be easily augmented by a suitable power unit for passing an electric current through the component to give a circumferential magnetisation, if it is desired to test for longitudinal cracks. In this case, since the magnet head is insulated from the bed-plate, the cables from the power unit can be bolted directly on to each head. The spring loading then provides the end-pressure required for good electrical contact while the copper-braid pads increase the contact area and reduce the heating. Thus, two magnetisations, 90 deg. apart, may be applied either simultaneously or separately to a component under test to detect both longitudinal and transverse faults.

PROBLEMS OF FLUID-FLOW MEASURING DEVICES.

Fig. 1.

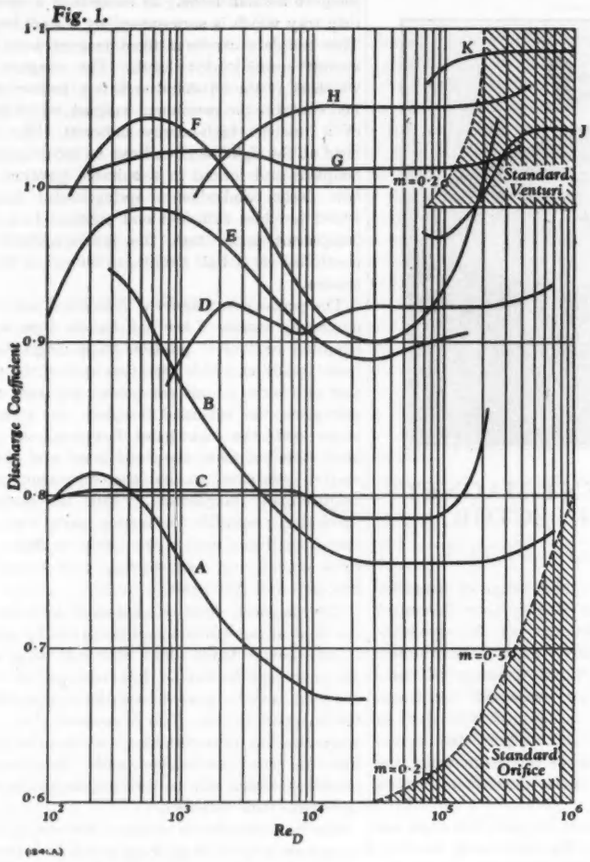
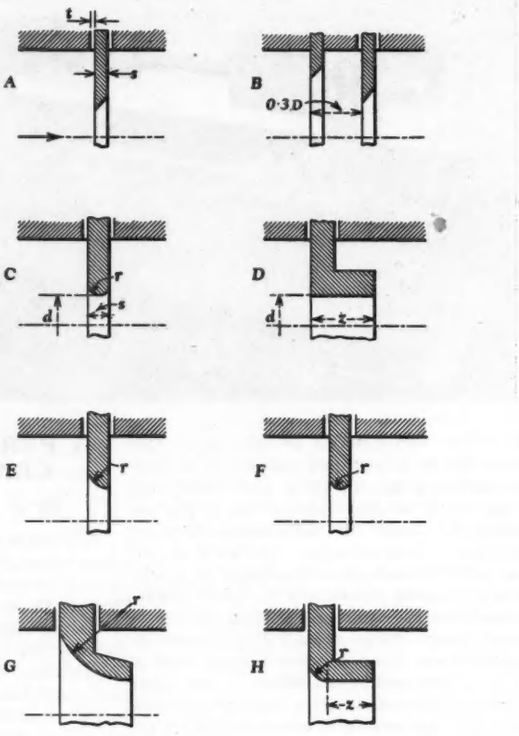


Fig. 1. (a)



"ENGINEERING"

SOME PROBLEMS OF FLUID-FLOW MEASURING DEVICES.

By F. V. A. ENGEL.

FLUID-FLOW problems in pipe lines of circular cross-section, in open channels or along a flat plate, particularly with reference to the mechanism of turbulence, have stimulated research and been the subject of comprehensive surveys by many well-known authorities. Experimental and theoretical investigations have definitely enlarged our knowledge of turbulent flow, in spite of the fact that a solution which can be applied generally to all the problems involved has yet to be established. On the other hand, the author is not aware of any investigation in the field of flow measurement which has led to comparable results, namely enhancing or elucidating our knowledge of fluid mechanics. This is somewhat surprising, as contracted passages, such as orifices, nozzles and Venturis, are simple geometrical patterns and the results obtained by studying them may be just as widely interpreted as those obtained by studying unrestricted passages. The main reason for lack of interest may well be that more advanced conclusions can be drawn only from test data of a very high degree of accuracy. It should be emphasised that these are by no means academic problems. On the contrary, these investigations lead to advanced designs and greater accuracy in fluid-flow measuring devices. The trend of this work should result in standards comparable with those already obtained in the field of electrical measurement.

Some of the basic principles employed in the present investigation, which have to be used in analysing test results and form the background of this work, have been established by mathematicians and physicists over a considerable period of time.

NOTES FOR FIG. 1 (a).

A Johansen.
D = 3·194 cm.
m = 0·354
t = 0·05 cm.
s = 0·15 cm.

B Koennecke No. 670.
D = 4·0 cm.
m = 0·504
m′ = 0·878
m″ = upstream orifice

C Koennecke No. 422
D = 4 cm.
m = 0·1225
r = d/8
s = d/4

D Koennecke No. 370f.
D = 4 cm.
m = 0·49
z = 2·86d.

E Koennecke No. 272.
D = 4·0 cm.
m = 0·490
r = 0·123d.

F Koennecke No. 472.
D = 4·0 cm.
m = 0·490
r = d/8

G Koennecke No. 279.
D = 4·0 cm.
m = 0·490
r = 0·446d.

H Koennecke No. 372e.
D = 4·0 cm.
m = 0·490
r = 0·143d.
z = 0·54d.

J Engel No. 58.
Venturi Fig. 10 of this article.
D = 6·008 in.
m = 0·4981

K Engel No. 62.
Venturi Fig. 10 of this article.
D = 6·008 in.
m = 0·4981

Unfortunately, this information is scattered over journals or monographs which are seldom scrutinised by engineers or which, for one reason or another, are not accessible to them. As the author is neither a mathematician nor a physicist, he claims no right to improve on the established relationships and on subjects which are outside the engineering domain in general. Nevertheless, a survey of the results achieved by these scientists would seem to be of the greatest importance. "Re-search" covering a period of about 80 years revealed a surprising lack of correlation and co-operation. Periodically, the same problem was taken up without reference to previous investigations in the field. It is, therefore, one of the chief aims of this article to arouse the interest of the mathematician, the physicist and the engineer in closer co-operation in the future.

It should be noted that in the following sections, orifices, nozzles and Venturis will be dealt with on a common basis. They represent two ideal limiting cases, the sharp square edge, without any rounded entrance, and the well-curved entrance.

In general, the notation employed follows that recommended by B.S. Code 1042 : 1943 (Flow Measurement). Some additions and also notations differing from those given in the above-mentioned Code are given below. Some of them are also supplementary to those explained in the article.

A	= cross-sectional area of conduit.
a	= variable area.
g	= acceleration due to gravity.
k	= a constant = 0·4 in the Bakhmeteff relationship.
ln	= symbol used to denote a Napierian logarithm.
P	= impact pressure.
p	= absolute static pressure.
Q	= volume rate of flow.
r_1	= radius of upstream pipe section.
r_2	= radius of throat section.
r	= perpendicular distance from axis of pipe.
r_0	= radius of pipe, in general.
U	= mean velocity of fluid, i.e., volume rate of flow divided by cross-sectional area.
u	= local and variable velocity of fluid particles.
$u_{max.}$	= maximum velocity in centre of velocity profile.
α, β	= correction factors.
δ	= thickness of displacement layer.
λ	= pipe friction coefficient.
ρ	= mass density.

The Geometry of the Contraction.—Orifices, nozzles and Venturis may be considered as contracted pipe passages, distinguished merely by their geometrical outlines and dimensions. The engineer is par-

FLUID-FLOW MEASURING DEVICES.

Fig. 2.

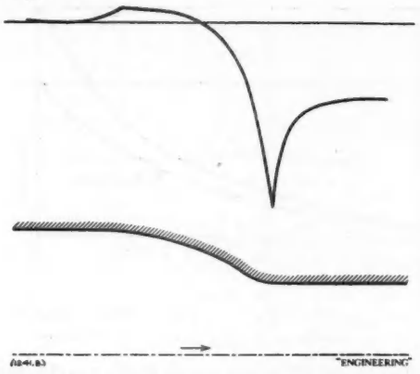
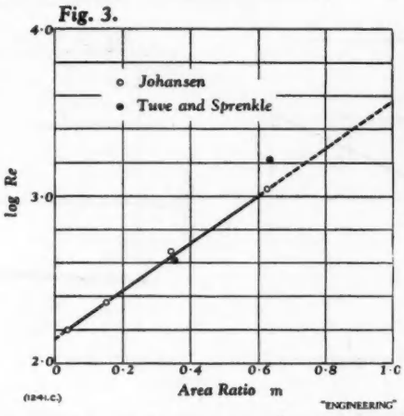


Fig. 3.



ticularly interested in a constant discharge coefficient over a wide range of velocities, which are normally interpreted by and related to Reynolds numbers. This dimensionless group, the Reynolds numbers, enables one to apply test results and generalise them with regard to pipe diameters, varying velocities or viscosities.

The pronounced influence of the geometrical outline and the layout of the contraction, even for the ranges within which constancy of the discharge coefficient prevails, is evident from Figs. 1 and 1(*a*), on the opposite page. In Fig. 1 the discharge coefficient includes the velocity of approach factor and the Reynolds number refers to the pipe diameter. These diagrams cover all designs from a sharp, square-edged orifice to various types of nozzles and the standard Venturi tube. For both the standard orifice and Venturi, limiting curves beyond which the coefficient remains constant are indicated in the right-hand corners of the diagram. The shaded range to the right of these curves refers to the normal field of application in waterworks, steam-raising plants and many other industries. The range to the left of the curves is related to the special problems connected with the measurement of viscous fluids and indicates the efforts to establish suitable designs which, over a measuring range of 1 to 10, show a sufficient constancy of the discharge coefficient for all practical engineering purposes. Some of the measuring devices give a particularly good performance, whereas others do not show any regularity. The selection of these curves was made chiefly from the research work done by Koennecke (1938).

The numerical value of the coefficient is definitely determined by the geometrical shape of the device, but below Reynolds numbers of about 100,000 there is a pronounced viscosity influence. This is particularly emphasised in ranges for Reynolds numbers smaller than 10,000. It is interesting to note that at this number a marked break occurs in many of the curves, most probably due to an extended transition range.

As regards this short survey, the engineer will be mainly interested in two questions. Firstly, is there any way of determining the influence of the geometrical outlines of the measuring device on the discharge coefficient? Secondly, is it possible to establish the numerical values of the discharge coefficient and to predict in which direction variations in its numerical value are likely to occur? The following considerations will show that both questions can be answered in the affirmative, in spite of the existing limitations with regard to the application of some of the basic assumptions.

The Bernoulli theorem is usually the foundation for calculations in the field of fluid measurement. In its conventional form, it represents the law of conservation of energy and does not take into account: (1) irreversibility due to friction, impact, etc.; (2) varying velocity distribution across the conduit due to the state of turbulence, which can be functionally related to the Reynolds number and/or the roughness of the wall surface; (3) curvature of flow filaments, which may lead to separation of the main fluid stream from the wall surfaces of the measuring device, resulting in a contraction of the main stream and eddy formation; and (4) a displacement or boundary layer. These conditions, which are mainly due to viscosity influences, differ from those of irrotational flow, the latter being a basis of mathematical approaches to fluid dynamics. In spite of these limitations, important conclusions can be drawn from the various methods based on potential theory, particularly for fully-developed turbulence, when viscosity influences may become irrelevant. This statement may be considered a paradox in the case of fully-developed turbulence with its high vorticity. Nevertheless, the experimental results closely approach calculations based on irrotational flow.

The mathematical methods used for the solution of potential problems are rather complicated and few engineers who are interested in fluid-flow measurement will be sufficiently familiar with these procedures. In the following paragraphs, therefore, only results will be discussed and for further information reference should be made to the bibliography, to be published after the conclusion of the article, which lists the more important publications on this subject. The three investigations mentioned below should be considered as important guides for determining the influence of the geometrical layout of the contraction.

(1) Kirchhoff (1869) investigated the contraction of a jet of perfect fluid through a narrow slit in a plane, the length of this slit being infinite. He obtained, on the basis of conformal transformations, the coefficient of contraction $\frac{\pi}{\pi + 2} = 0{\cdot}611$. (2) The influence of a very small rounding off of a normally sharp, square edge was dealt with by Rothe and others (1933), with reference to the potential field close to the corner of a pole of a magnet. They showed that even a very small radius breaking the sharp edge exercises a considerable influence. No investigation which applies this method to fluid flow could be found by the writer. Its significance for exact measurement, however, is known to every engineer in the field. Fig. 1 shows how a rounded entrance of the contraction results in discharge coefficients of 0·8 and higher. (3) Matsumoto (1931) investigated the pressure distribution along the wall of a Venturi. Close to the beginning of the cylindrical part of the contraction there exists a very steep pressure gradient as shown in Fig. 2. The upper curve represents the pressure distribution along the wall of the Venturi which is illustrated by the shaded line. A pressure gradient due to curvature of flow filaments has, of course, been known for a long time and has been dealt with in numerous papers and text-books. In general, the pressure distribution in these investigations is represented by a well-rounded curve forming the minimum value. The mathematical method employed by Matsumoto results in a pointed minimum formed by two steeply descending curves of somewhat hyperbolical character. It was this type of curve which stimulated the research work on Venturis which will be dealt with at length later in this article.

The engineer may consider these three statements as "mathematical models"* of limited practical value and merely as a guide in his investigations. It is obvious from Fig. 1 that over very extensive ranges the viscosity influence is predominant, and therefore from the beginning the supposition of irrotational flow when dealing with many practical problems is not correct. None of the investigations which came to the notice of the author indicated within which range of Reynolds numbers the results could be applied.

These remarks should not, however, divert attention from the fact that the three methods of investigation mentioned above form a very valuable guide for experimental research. Kirchhoff's figure for the contraction coefficient and the elucidation of his investigation by Lord Rayleigh (1876) must be considered as important steps forward. The broad outlook as represented in a series of articles by von Mises (1917) closely approaches the engineer's point of view and very few publications since that date have advanced the subject to any great extent.

Some of the investigators do not seem to be aware that in many countries the discharge coefficient of an orifice in a pipe line is given in standard specifications, such as B.S. 1042 : 1943. The maximum value of the discharge coefficient is given as 0·606 over a wide range of area ratios, with a deviation of 0·5 per cent. covering ratios from 0·15 to 0·5. The figure 0·611 given for the contraction coefficient† by Kirchhoff approaches the above-mentioned discharge coefficient so closely—considering the limitations of irrotational flow—that only a notable improvement on Kirchhoff's figure could convince the engineer of the practical purpose of a new investigation. He will certainly be very reluctant to concede that any improvement has been made if the numerical value is lowered 1·5 per cent. by narrowing down the approximation process, as has been done in a recent publication, or, to accept any evaluation method stated elsewhere, which gives results with an accuracy of $\pm$ 2 per cent. only. This figure does not seem particularly good in comparison with the well-established values of discharge coefficients as recommended by many national standards committees.

A fairly wide survey of further publications on the Kirchhoff problem is not illuminating with regard to an easy way of reconciling theory and experiment. Some of the authors do not refer to the work done by previous investigators. Further progress can only be made by a systematic study of the subject. For this purpose, the following publications, in addition to those already quoted, may be consulted: Birkhoff (1950), Boussinesq (1877), Hansen (1949-50),

* The "mathematical" model should be contrasted with the "workable" model (Engel 1949). That many of the mathematical models are not absolutely true is shown by the multitude of coefficients which have to be applied in engineering, proving that the premises or presumptions of the mathematical approach are either insufficient or incorrect. As regards the numerical values of such coefficients, they may be either smaller or larger than unity.

† It must be pointed out that the discharge coefficient and the coefficient of contraction are not identical. The close agreement in their numerical values should not obscure the essential difference in their natures. A careful analysis of this point would seem to be very necessary, but would be outside the scope of this article.

PROBLEMS OF FLUID-FLOW MEASURING DEVICES.

Fig. 4.

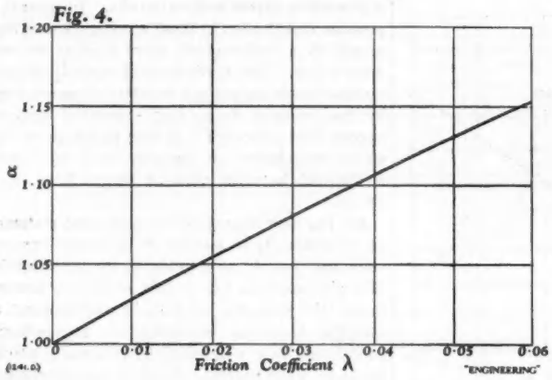
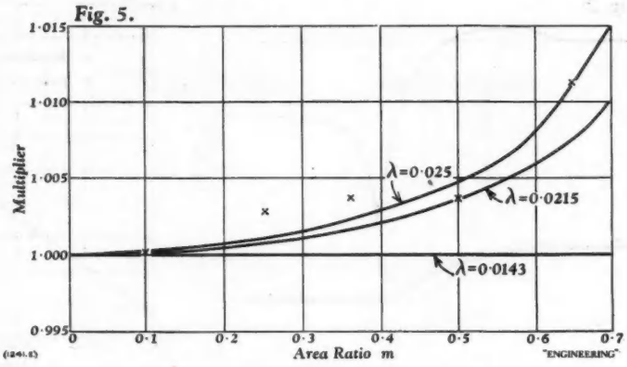


Fig. 5.



Kretzschmer (1936), Rouse and Abul-Fetouh (1950), and Smith and Walker (1923).

Dimensionless Groups as a Basis of Flow Analysis.—Geometrical outlines of the contraction not only determine the numerical value of the discharge coefficient, but also influence the range over which it may be considered to be constant. In addition, over large ranges, Fig. 1 shows considerable changes in the discharge coefficient as a function of the Reynolds number, i.e., mainly a viscosity influence. This may be interpreted as being due to streamline conditions in the range of low Reynolds numbers, to extended transitional conditions up to Reynolds numbers of the order of 100,000 and, as shown later, to a displacement layer which narrows the effective cross-section of the Venturi.

In Fig. 1 a specific feature of dimensionless groups has been used, namely, the representation of test results in this particular case as a function of the Reynolds number. Any diagram of this kind is a useful tool, as such results can be generally applied, providing that "similar" conditions prevail. Normally, the interpretation of "similar" also includes geometrical similarity. There are, however, modes of flow for which geometrical similarity is not essential, as, for example, for the orifice plate for streamline flow. Most of the curves for very low Reynolds numbers almost coincide, irrespective of the value of the area ratio. The investigation outlined in the present section, however, will be mainly concerned with "critical" numbers which distinguish various types of flow conditions and indicate the limits for constancy of discharge coefficients.

The sharp and square-edged orifices will be considered first. The variation of the discharge coefficient for low Reynolds numbers and its steeply ascending slope may be explained by the fact that investigators usually apply a relationship in which the velocity is proportional to the square root of the differential head. Strictly speaking, this is only true for fully developed turbulence. In the range of viscous flow the velocity is directly proportional to the differential head itself. This difference in the fundamental laws accounts for the large variation in the numerical values of the discharge coefficients. Owing to the application of the square-root relationship to ranges of viscous flow, the discharge coefficient may even exceed unity.

A diagram may be prepared in which the peak points in the discharge-coefficient curves are represented by their correlated Reynolds numbers and plotted against the area ratio. In Fig. 3, page 7, the ordinate gives the logarithm of these Reynolds numbers referred to the throat diameter d. Johansen investigated sharp orifices and Tuve and Sprenkle (1933) square-edged orifices with a short cylindrical throat. Fig. 3 may be applied to give an interpretation of "lower" or "upper" critical Reynolds numbers. The extrapolation of the curve to the left-hand side in Fig. 3 results in a lower "critical" Reynolds number of about 140, which refers to a very small area ratio, that is, one which approaches zero. Orifices with such area ratios may be considered as a source of disturbances, which results in the formation of eddies for certain Reynolds numbers, as tests by Johansen (1929) have shown. As the range of Reynolds numbers considered is still within the region of streamline conditions for straight pipes of circular cross-section, these flow disturbances should be viewed as being of "quasi-turbulent" nature. At a point sufficiently far from the orifice plate, that is, about 100 pipe diameters, all eddies should have died out and ordinary streamline flow should have been re-established.

The discharge coefficient should be considered as a function related to two consecutive sections of the fluid stream, $C = f(Re_D, Re_d)$, Re_D referring to the pipe diameter and the section immediately adjacent to the orifice plate, and Re_d referring to the cylindrical part of the orifice area. As for an incompressible fluid $Re_D = Re_d \sqrt{m}$, it is evident that Re_d increases rapidly when the area ratio approaches zero. In this case, the magnitude of disturbance may be considered to be sufficiently large to result in a state of quasi-turbulence across the orifice plate, providing that a "critical" value is reached as indicated in Fig. 3. The figure of 140 seems to be close to a value established by Synge (1938) in a mathematical investigation on the stability of plane Poiseuille motion, which "is stable for disturbances of any wavelength if the Reynolds number satisfies $Re < 155$."

Another way of approach to the "lower" critical Reynolds number is indicated in research work done by Davies and White (1928). Using a duct of rectangular section, they reached the conclusion that "By employing progressively shorter 'entrant lengths' evidence has been found suggesting the existence of a third or 'lowest' critical point, in the neighbourhood of $\frac{\rho v d}{\mu} = 140$, below which eddies are not transmitted along a pipe." The entrant length ($L = 1{\cdot}25$ cm.) is given by the length of the rectangular duct, which also coincides with the distance between the two pressure tappings. The variation in the ratio of length to depth was obtained by running a series of tests with various conduit depths. The lowest ratio thus obtained was about 18, but two further tests were conducted with ratios of about 8 and 4, respectively, by using $L = 0{\cdot}2$ cm. and $L = 0{\cdot}1$ cm. The critical value below which "eddies cannot exist" ("whatever may be the pre-entrant conditions, eddies cannot be transmitted to, or exist in, the channel when the Reynolds number is less than 140") was established by extrapolation to zero entrant length. This result is distinct from the first one for orifices with a diameter approaching zero, as in the tests by Davies and White zero entrant length was obtained by increasing the depth of the conduit and, in two special tests, by decreasing the distance between the tappings.

Ostwald and Auerbach (1926) dealt with a third method of approach to a "lower" critical Reynolds number, namely, for unsteady flow. In their investigations of the capillary-type viscometer they obtained a critical value of about 270. The capillary was attached to a long, vertical glass tube with a bell-shaped mouth part forming the entrance to the capillary. In this case the instrument works with a falling liquid level, which results in unsteady flow conditions, the velocity being comparatively large at the beginning of the test and decreasing with the drop in head. The authors observed that at the beginning of the test turbulent flow conditions may prevail, while streamline conditions may be encountered at the later stages of the test run, due to the decreasing head. The length of the capillary tube was varied from 5 to 70 tube diameters.

Extrapolating the straight-line relationship as given in Fig. 3, up to an orifice approaching the cross-section of the pipe line, would result in an "upper" critical Reynolds number of about 3,600. (See Engel and French, 1936.) An analysis of the numerous tests made by Koennecke (1938) does not show that the critical number of 2,300 has any definite influence on the characteristic of the discharge coefficient. This may be due to the fact that the devices he used were vastly dissimilar for various area ratios. Furthermore, the straight pipe section in the lay-out of the test arrangement for the approach was only of the order of 20 pipe diameters, which may not be sufficient to establish a normal viscous-flow profile.

In some engineering books the meaning of the critical Reynolds number has not been dealt with adequately. Reference is only made to the value of 2,300 which, of course, applies only to a straight pipeline of circular cross-section. Often no warning is given that this value does not apply to other problems or designs. In some cases in Fig. 1, streamline conditions break down for Reynolds numbers of about 500. In one case, a peak value of the discharge coefficient is reached at 3,000. Both these values refer to the pipe diameter and have to be divided by $\sqrt{m}$ to be comparable with Fig. 3. There is, however, no definite relationship between the two and therefore it has not been considered worthwhile to put these results on a common basis. For nozzles and the Venturi, the peak points of the discharge coefficients are only reached for Reynolds numbers of the order of 100,000 to 200,000. This is most probably due to a displacement layer, which may, depending on the position of the tapping, disappear for Reynolds numbers exceeding 500,000.

This survey settles the questions of "lower"

FLUID-FLOW MEASURING DEVICES.

Fig. 6.

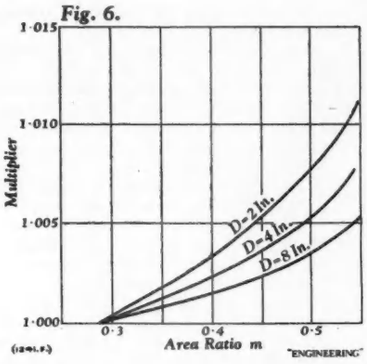
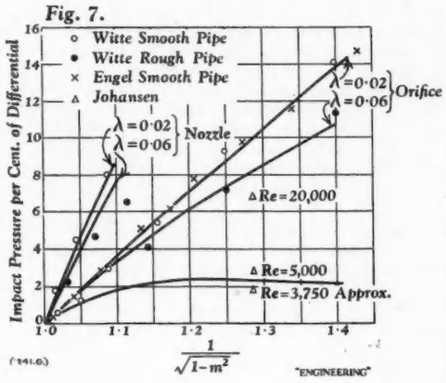


Fig. 7.



and "upper" Reynolds numbers for fluid-flow measuring devices covering the range of Reynolds numbers from 140 up to 200,000. These critical values establish lower limits beyond which no constancy of the discharge coefficient may be expected. As shown, the geometrical outlines of the measuring device exert a considerable influence. Another aspect of the application of dimensionless groups as the basis of flow analysis, namely, the issuing of a free jet of one fluid into another medium, has been dealt with by Hansen (1949-50).

For free jets flowing out of orifices and nozzles, three dimensionless groups have to be considered, namely, Reynolds, Froude and Weber numbers. Unfortunately, some investigations present hydraulic coefficients as a product of powers of such groups. This, however, is only correct for very restricted cases, for example, in heat transfer, with two groups of similar configuration. A proof that such a procedure may result in contradictory statements can be obtained by inserting into the three above-mentioned groups a series of values for the velocity term. That products of dimensionless groups can form the basis for representing coefficients or other quantities is a statement of a limited nature. Dimensionless analysis can only show that a quantity may be a function of dimensionless groups, without indicating the type of function. The problem of flow of a free jet is not only related to measuring devices, but is also of great interest in relation to plant conditions in chemical engineering, for example the extraction plants. However, sufficient experimental results are not yet available to settle these problems conclusively.

Influence of Velocity Distribution in the Approach.—In addition to the geometrical outlines of the contracted passages, geometrical dimensions (such as the pipe diameter), the roughness of the approach section and fluid-flow conditions represented by the Reynolds number and related to a frictional factor, all have to be taken into consideration when analysing the discharge coefficient. These influencing factors are commonly grouped together and dealt with as "scale effect." An investigation based on the velocity distribution across the conduit in the approach section of the measuring device may help to elucidate this term.

In hydraulic engineering, the influence of the velocity profile in general is often ignored. The comprehensive studies of Boussinesq (1877) and of de Saint-Venant (1887) have hardly found any practical application, in spite of the fact that from time to time well-known authorities have taken up related problems, namely, the Bernoulli theorem and Newton's second law of motion. In this particular investigation of contracted pipe passage, the stream filaments are bent inwards towards the throat, resulting in a phenomenon known as "impact pressure." This impact pressure is proportional to the rate of change in axial momentum. In the following paragraphs only the broad outlines of this subject can be given and for further information a previous publication should be consulted. (Engel and Davies, 1938.)

The complete Bernoulli theorem for an incompressible fluid should be written thus:—

$$p_1 + \tfrac{1}{2}\alpha_1 \rho U_1^2 = p_2 + \tfrac{1}{2}\alpha_2 \rho U_2^2$$

in which

$$\alpha_{1,2} = 2\int_0^1 \left[f\left(\frac{r}{r_0}\right)\right]^2 \frac{r}{r_0} d\left(\frac{r}{r_0}\right).$$

In the terms for α, the velocity distribution across two successive pipe sections is taken into account by the Prandtl-Bakhmeteff relationship, namely:

$$\frac{u}{U} = f\left(\frac{r}{r_0}\right) = \frac{1}{k}\sqrt{\frac{\lambda}{8}}\left\{\left(\frac{3}{2} + k\sqrt{\frac{8}{\lambda}}\right) + ln\left(1 - \frac{r}{r_0}\right)\right\},$$

which enables one to evaluate it on the basis of the pipe friction factor λ.

These relationships can only be applied for cross-sections of the conduit where the profile is not yet influenced by the contraction. For a section immediately facing the entrance of a contracted passage, the above-mentioned equations are meaningless. As already stated in this section, most of the stream filaments are bent inwards towards the throat of the restriction, resulting in an impact pressure P which is proportional to the rate of change in axial momentum, i.e.,

$$P \propto \rho U^2 \frac{2}{1-m}\int_{\sqrt{m}}^1 \left[f\left(\frac{r}{r_0}\right)\right]^2 \frac{r}{r_0} d\left(\frac{r}{r_0}\right),$$

resulting in a correction β.

$$\beta = \frac{2}{1-m}\int_{\sqrt{m}}^1 \left[f\left(\frac{r}{r_0}\right)\right]^2 \frac{r}{r_0} d\left(\frac{r}{r_0}\right).$$

In general hydraulic engineering comparable corrections α and β have been dealt with by von Mises (1914), O'Brien (1934) and other authors. Starting from the relationships for α and β

$$\alpha = \frac{1}{U^3 A}\int_0^A u^3\, da \qquad \beta = \frac{1}{U^2 A}\int_0^A u^2\, da,$$

numerical values for smooth and rough surfaces are as follow:

$$\alpha = 1{\cdot}085 \text{ to } 1{\cdot}15 \qquad \beta = 1{\cdot}028 \text{ to } 1{\cdot}05.$$

An approximate method of determining numerical values was given by von Mises on the basis of the maximum velocity:

$$u_{max.} = (1 + \varepsilon)\, U$$

and

$$\alpha = 1 + \varepsilon^2, \qquad \beta = 1 + \frac{\varepsilon^2}{3}.$$

As these relationships were established before the fundamental equations for the friction coefficient λ, depending on pipe roughness and Reynolds number were known, the Prandtl-Bakhmeteff equation is of much more value.

In the various standards for and reports on flow measurements, no reference is made to any correction based on the above formulæ. This is somewhat surprising, as the problems have been dealt with by such authorities as Boussinesq (1915) and Burgers (1923), but even their investigations have not been referred to in later publications on this subject.

For an upstream tapping either $\frac{1}{2}$D or D in front of the contraction, the flow equation generally used is:

$$Q = C A_2 \sqrt{\frac{2gh}{1-m^2}},$$

which based on the enlarged Bernoulli theorem results in:

$$Q = C' A_2 \sqrt{\frac{2gh}{\alpha_2 - \alpha_1 m^2}}.$$

The correction factor of the first equation—assuming, further, $\alpha_2 = 1$, which is a limiting case, meaning a flat velocity profile in the throat of the contraction—results in:

$$C_{corr.} = \frac{C'}{C} = \sqrt{\frac{1-m^2}{1-\alpha_1 m^2}},$$

α should be correlated to the friction coefficient λ as shown in Fig. 4 opposite.

When applying this correction to any specific case, it may be useful to establish a correction coefficient which represents the ratio of the discharge coefficients for a smooth conduit (small λ-values) to that for a rough one (large λ-values). Fig. 5 is based on this procedure and gives results obtained from tests by Rousselet and Schlag (1950) on conical Venturis with both a smooth and a rough pipe in the approach section. As these authors had established the C values, it was possible to prepare corresponding curves against the area ratio as abscissæ. The agreement between the curves calculated according to the above formulæ and the test points is very good, even though the accuracy of the tests is not more than 0·5 per cent.

Fig. 5 may also be compared with the corrections for D for a nozzle Venturi as given in B.S. 1042: 1943. Fig. 6 bears a close resemblance to Fig. 5, which is very remarkable. The smaller pipe diameter refers obviously to a greater relative roughness, which, in turn, means a larger λ value. The corrections for D, in the case of conical Venturis and orifice plates, account for other influencing factors and were therefore not comparable. These can be amended as our knowledge advances. It may be of interest to note that Boussinesq (1915) gave a correction factor as follows:

$$C_{corr.} = 1 + \frac{m^2}{2}(\alpha_1 - 1).$$

This, however, results in a correction of only about half that given in the present article.

Great emphasis must be given to the fact that measurements made D or $\frac{D}{2}$ upstream from the entrance of the restriction require an α correction, while those referring to the entrance face require β corrections. Fig. 7 has been prepared from and based on such β corrections, bringing the values for moderately smooth pipes ($\lambda = 0{\cdot}02$) into line with the test results obtained by Witte (1931) and the author. (See Engel and Davies, 1938.) The test points for $\lambda = 0{\cdot}06$ and those of the nozzle test agree closely with the calculated values. Furthermore, some test results obtained by Johansen (1929) are plotted in the same diagram. They approach the curve for the parabolic profile, which is the lowest curve in the diagram. The curve for the parabolic velocity distribution for streamline flow is the lowest one in the diagram. However, the present evidence cannot yet claim to be conclusive.

The magnitude of the correction for the change in velocity profile expressed as $\lambda = 0{\cdot}02$ (smooth surface) and $\lambda = 0{\cdot}06$, respectively, is about

3 per cent. for the pipe tappings and less than 1 per cent. for the corner tappings. As the experimental evidence for this statement has not yet been sufficiently proved, with the exception of the test results already discussed, further research in this direction is advisable.

In the derivation of these various relationships, the the starting assumptions have been somewhat over simplified. More advanced equations have already been discussed by von Mises (1914). However, their evaluation seems not only to be very laborious, but it is also doubtful whether they could improve on the close coincidence of experimental results in the region of fully developed turbulence with the calculated values. The problems of viscous flow and transitional conditions have not yet been covered.

(To be continued.)

THE MACHINE TOOL INDUSTRY.

THE Council of the Machine Tool Trades Association have issued a statement of their comments on the report of the British metalworking machine-tool productivity team. A summary of the statement is given below.

Some of the conclusions and recommendations (not all of them unanimously subscribed to by the members of the team) were of a particularly controversial nature and have been regarded in many quarters as calling for a pronouncement of views by the Machine Tool Trades Association. The issuing of these comments is, therefore, distinct from and in addition to the normal procedure of a sponsoring body in lending its aid in every way to the implementation of report recommendations. The productivity team was sponsored by the Machine Tool Trades Association, the Engineering and Allied Employers' National Federation, and the Confederation of Shipbuilding and Engineering Unions.

It immediately appeared that the substance of the report causing controversy was contained in the summary of conclusions and recommendations (pages 1 and 2), chapter 5 of the report (pages 42 to 53), and the letter presenting the report to the Machine Tool Trades Association and other sponsoring organisations, and attention is therefore confined in these comments mainly to those sections.

Conclusions (Team Report, page 1).—In the team's conclusion No. 3, that "In both countries sales are limited by high prices," the use of the word "prices" is regarded as misleading. What is understood to have been intended is "costs." The productivity of a machine rather than its cost is the measure of its sales value. Conclusion 12, concerning rationalisation, "There are as few signs of industry-wide rationalisation in the American as in the British machine tool industry," is regarded as misleading as written. The degree of rationalisation in the industries of the United Kingdom and United States differs very little. There are now as few firms in the one country as in the other who have not to some extent rationalised their production by specialising in a certain type of machine tool.

Recommendations.—Short-Term (Team Report, page 2).—"1. To revert to 'war-time' finish both as regards paintwork and metal finishing."* It is considered that insufficient regard has been had for consumer reaction. It is undeniable that the United Kingdom, with its high dependence on the export market and its concern with European competition, must consider the outward appearance of its products. The increase in productivity arising from the adoption of this recommendation would be negligible; the psychological effect in makers' and users' shops would be lamentable and the effect on export sales disastrous.

"4. That inspection costs should be reduced by applying simple statistical control to the amount of inspection carried out on any individual batch of components." This could better have been expressed: "That consideration might be given, wherever appropriate, to the reduction of unnecessary inspection costs."

"5. To specify a softer cast iron for the general run of machine tool castings, to ease machining." The team's approach to the specification of materials appears unrealistic and has failed to take into account the differing conditions in the two countries. In this country sufficient pig iron of low phosphorus content is not available to iron foundries. Even if, as might be the case, British machine-tool makers were specifying a higher Brinell figure than was absolutely necessary, could it really be said that the difference between 160 Brinell and 200 Brinell makes any great difference to machining? There might be some small advantage in respect of tool life.

Medium-Term (Team Report, page 2).—"1. To educate customers in general to judge machine tools on performance, not on appearance" and (Short-Term Recommendation 5, page 53) "The industry to re-educate customers to buy machine tools on the basis of what they will do rather than on what they look like. The cost of all the 'spit and polish' must be passed on to the customer, who gets no more profit from it."

It is believed that the majority of customers, when buying, do put performance first, and there is not, therefore, much room for educating customers in this respect. On the other hand, poor finish might well prejudice a customer against a machine whose performance is good.

Medium-Term (page 2).—"3. To allow of a more utilitarian basis for the preparation of drawings and save considerable man-hours in drawing offices with no loss to the manufacturing departments." See later comment. "4. To introduce 'productivity-mindedness,' initially to the design side of the industry, from some high-productivity industries." Experience shows that the word "extend" should be substituted for "introduce."

Long-Term (page 2).—"1. To reduce considerably the number of independent manufacturing companies in the industry, by absorption, amalgamation or any such means that will allow of greater standardisation and concentration"; and "2. To examine, develop and implement a system of 'standardised unit' construction for the bulk of machine tools, aiming at volume production of industry-wide common units to manufacture low-prices, simple machines." It is strongly felt that the first long-term recommendation is one that should not have been included, tending as it does, to suggest a certain degree of tolerance for the idea of the establishment of a monopoly.

Chapter 5. "Suggestions for Improving Productivity" (page 50).—"When it is said that a nation, or an industry, or a plant must increase its productivity the conclusion drawn is usually that the people in such a unit must work harder. It is true that if they do work harder productivity will probably increase, but the greatest and most lasting increases in productivity are not dependent on increasing effort at all; in fact, the required effort is often reduced considerably. The productivity of motor-car firms or machine-tool firms is very much higher to-day than it was, say, 40 or 50 years ago, but it is safe to state that the operatives of 40 or 50 years ago had to work much harder than do operatives in such industries to-day. The increase in productivity has been due almost entirely to the efforts of management in its broad aspect, and the machine tool industries of both the U.K. and the U.S. must look principally to this source to engineer further necessary increases in productivity. This fact of relative influence on productivity is, however, no justification for any operative giving less than a fair return for his day's pay; operatives still have the short-term aspect of productivity very much in their hands." It is suggested that the report has failed adequately to emphasise the important contribution which our workpeople can make to increased productivity in the machine tool industry by the full use of machines at their disposal.

"As a longer-term policy, it would be advantageous that all design personnel should have had experience in a time-study or a rate-fixing department, so that the relative cost of everything put into a design will be appreciated; it would add interest to the designer's job and would certainly result in cheaper design. Productivity-mindedness of a higher order should be introduced into the machine tool designs department." It is desired to underline the suggestion that designers should be in closer touch with production methods and costs than is often the case, even to the extent that all designers should serve a part of their training period in the workshop.

"With possibly a few exceptions the British machine tool industry and, as far as we could ascertain, the American machine tool industry, make their drawings in the traditional way—all straight lines and precise curves, all to scale, and often requiring large staffs of draughtsmen to produce them.

"There is being put into practice in the U.S. (not in the machine tool industry as far as we could ascertain) a more realistic appreciation of what a drawing need only be—merely a method of indicating dimensions in the correct relation one to another, or of the position of components or units relative to one another in an assembly.

"One at least of the largest companies in the U.S. is now in process of reducing considerably its use of straight edges, squares, etc., and is having many of its drawings done free-hand on squared paper, the squares being such that they do not develop on to the 'print.' Dimensions are practically all from a datum line. Draughtsmen are not allowed to print letters or figures; they only write them, and a special machine, operated by a woman, types the words and figures. The drawings need not be even to correct shapes . . . .

"The application and development of this time-saving idea by the machine tool industry and, in fact, by most industries, will enable drawing office staffs to be reduced considerably or, alternatively, much greater outputs obtained from existing staffs."

With regard to this suggestion that too much time is spent on the preparation of drawings, the recommendation (Team Report, page 2) covering the employment of more utilitarian methods for the preparation of drawings is accepted, but it is not accepted that the technique of free-hand drawings with dimensions subsequently typed in is likely to lead to an improvement in productivity.

Recommendations (page 53).—(a) For Industry on Short-Term Basis.—"4. The industry to introduce a uniform system of limits, and individual firms to use such a system, giving all their dimensions the widest possible tolerances." It is suggested that this is impossible of achievement in the short term. Bearing in mind, in particular, the work which has been done by the British Standards Institution and the International Standards Organisation, it is felt that this work cannot be accelerated without harm.

"6. Each firm to arrange for a higher standard of productivity-mindedness in its designs staffs, possibly by recruitment of suitable people from some mass-production industry, and to give 'design for cheap production' a top place. 7. Every firm to decide to content itself with a very much more realistic appreciation of what a drawing need be, and to discontinue the extravagance of existing drawing office practice." It is stated with confidence that this practice already exists in a large number of firms.

(b) For Industry on Medium and Long-Term Basis.—"1. A deliberate policy of rationalisation of design and concentration of manufacture to be implemented by the industry, to give the advantages associated with increased volume manufacture of the same product. 2. The machine tool industry, or a courageous section of it, to give serious thought to the possibilities of 'unit' standardisation and 'unit' construction for the majority of machine tools; to design progressive sizes of the various units. 3. Individual firms gradually to specialise, some on standardised spindles and housings, some on standardised driving units, some on standardised feed units, etc. 4. Assembly firms to make standard machines from bought-in standar. units; other firms to concentrate on the enormous field opened up for special machines made from standard units. . . . ." *et seq*, to Recommendation 8, inclusive.

These medium and long-term basis recommendations are believed not to be possible of implementation, but, even if they were, they would lead to confusion and stagnation in the industry.

* See also conclusion 5(b) of team report, page 1.

ULTRASONIC DETECTOR FOR FLAWS IN RAILS.

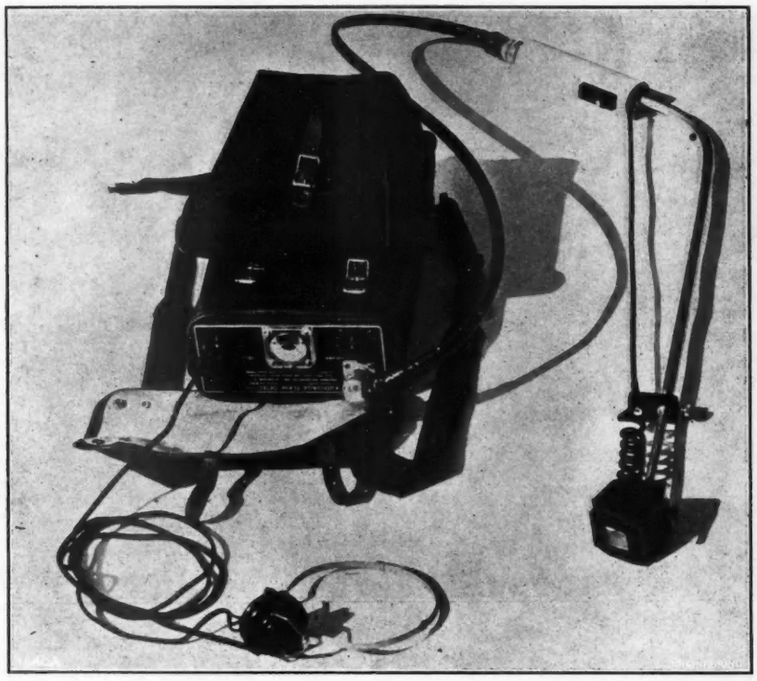


FIG. 1. CRYSTAL HEAD, CABLE AND CONTROL PANEL.

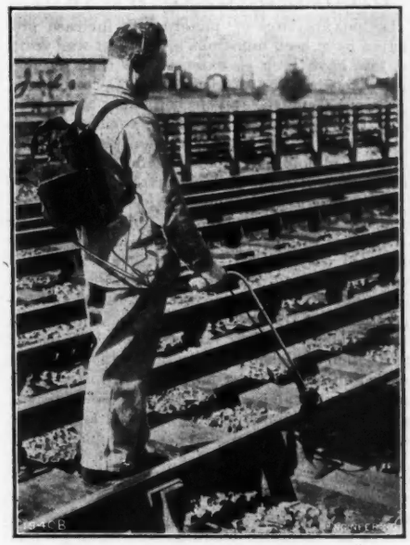


FIG. 2. DETECTOR IN USE.

GAS-TURBINE SET AT ENGINEERING, MARINE AND WELDING EXHIBITION.

AN industrial gas-turbine of a type now being batch-produced by Messrs. Ruston and Hornsby, Limited, Lincoln, is to be used to supply power in the exhibition halls at Olympia, London, during the period of the Engineering, Marine and Welding Exhibition, from September 3 to 17 this year. Visitors to the exhibition will be able to observe the unit running. It will be on a special site adjoining the Grand Hall.

The turbine is one of the firm's latest design—the Mark TA—the development and design of which were described on page 321 of our issue of March 13, 1953. It is a lightweight machine of 750 kW to 1,000 kW, adaptable to many purposes, and it is now being built for service with various fuels, including Diesel oil, natural gas and coal-tar fuel. The unit to be used at Olympia will be of the non-recuperative type, in which form it is conservatively rated at 900 kW, but this performance has been comfortably exceeded on long endurance running tests. A standard heat exchanger can be added without altering the rotating components or their casings. The turbine will be run on load for ten hours a day for the 13 days of the exhibition, supplying electricity for a considerable part of the lighting of the three main halls—the Grand, National and Empire Halls—and for certain power requirements of motors, etc., used at the exhibition. It will supply power to the Olympia sub-station at 6,600 volts, which will be transformed to 230 volts and 400 volts for lighting and power. The running periods and load carried by the turbine will be governed by the requirements of the exhibition, which preclude demonstrating the notable flexibility of control and rapidity of starting, since the machine will have to be on load one hour before the public are admitted each day. The turbine will therefore be run at a constant load throughout the 13 days of the exhibition.

The arrangements for this unique demonstration have been made by Ruston and Hornsby, Limited, in co-operation with the exhibition organisers (F. W. Bridges and Sons, Limited), the Olympia management and engineering department, and the London Electricity Board.

ULTRASONIC DETECTOR FOR FLAWS IN RAILS.

THE detection of flaws in steel rails has always presented difficulties, particularly when the flaws occur at the ends of the rails between the fishplates. Until recently, the method used in the United Kingdom for inspecting the rails has been only visual; this has had the disadvantage that it was only possible to detect the cracks when they had grown to a considerable size, and then only if they were not concealed by dust and dirt. The detection of incipient cracks was virtually impossible and, frequently, large cracks were revealed only when a periodic inspection was made that involved a thorough brushing and cleaning of the joint. A means of detecting the flaws by an ultrasonic beam has now been devised and it is embodied in the "Audigage" flaw detector, made by Branson Instruments Incorporated, Stamford, Connecticut, U.S.A. The instrument, shown in the accompanying illustrations, Figs. 1 and 2, consists of a small battery-operated generator of ultrasonic frequency and a receiver, which are carried together in an 11½-lb. pack on the inspector's back; the other equipment comprises a crystal in a holder on the end of a long handle, and a pair of headphones. The crystal head of the Audigage is applied to the crown of the rail and the existence of a crack is indicated by a lowering of the continuous tone that is produced in the 'phones by an uncracked rail. It is considered that, with a little training and experience, any operator (who is not tone deaf) would have no difficulty in using the instrument.

Three 1½-volt and two 67½-volt batteries supply current. The instrument contains three IU4 valves carried on a shock-proof sub-panel built into the principal housing. As shown in Fig. 1, on the cover plate are the tone and volume controls, a milliammeter for battery testing, a jack socket for the headphones and a multi-point connector for the crystal cable. The main on/off switch—a mercury contact in the crystal head—can be switched on only when the crystal head is held in a near vertical position ready for use; furthermore, the set cannot be turned on if the crystal cable is not plugged into the batteries. The set is carried in a knapsack, control panel upwards, with the headphones plugged in and the crystal cable connected, as shown in Fig. 2. The crystal head is placed on the rail (on which a thin film of oil has been spread to improve contact); the tone and volume are adjusted to suit the inspector, who then pushes the crystal head along the rail surface, making sure that the length of the crystal lies transversely across the rail. The ultrasonic beam travels down through the rail until it meets a surface that will reflect it. Normally, this surface is the underside of the rail or head, but in the case of a cracked rail the beam if reflected by the flaw, and a change of tone—usually a drop in tone—is noticed in the headphones. The nearer the flaw is to the surface the greater is the drop in the frequency. If the plane of the flaw is not substantially parallel to the head, the tone ceases altogether and no indication is given of the depth of the crack from the top of the rail, but its length, of course, can be gauged from the distance traversed by the crystal during the "no-tone" period.

Fishplates do not affect the proper operation of the instrument, as bolt holes give rise to a characteristic, and easily recognised, tone. A small flaw immediately below a bolt hole will not be detected, however, because of the interruption of the beam by the hole itself. Normal field maintenance of the Audigage consists of testing and replacing the batteries and replacing the valves. The plastic rubbing strip protecting the crystal also requires occasional renewal; the worn strip is removed by the aid of acetone—a solvent for the adhesive used for fixing the strip, which must lie flat against the crystal without voids.

One of the detectors has now been in use by the Permanent Way Department of London Transport Executive for a few weeks. During this time about 15 miles of track have been inspected with the assistance of the Audigage and several minor defects, not previously revealed by visual inspection, have been discovered in sections of rails close to joints.

THE LATE MR. B. THOMAS.—We regret to record the death of Mr. Bertram Thomas, which occurred at Dunham Massey, Cheshire, on Wednesday, June 17, in his eighty-seventh year. He received his technical education at Finsbury Technical College under Silvanus Thompson and then served his pupilage with Messrs. Woodhouse and Rawson, subsequently working on their staff. Nearly 60 years ago he established an electrical contracting business in Manchester, when he was responsible for wiring the Rylands Library in copper conduit, and some years later he began the manufacture of direct-current switchgear. Subsequently, he originated and manufactured storage tilt track gear for engineering purposes. He was elected an associate of the Institution of Electrical Engineers as long ago as 1887.

RE-ORGANISATION OF A DIESEL-ENGINE WORKS.

RE-ORGANISATION of factories to increase production have been numerous in the post-war years, but few have been so extensive as that recently undertaken at the Earlsfield works of Messrs. F. Perkins, Limited, at Peterborough. Since 1946, when the production of Diesel engines at this factory was 3,500 a year, the output has been increased tenfold, to 37,500 engines during 1952, Such, however, is the growing market for this type of engine that the planned capacity of the re-organised factory is to be 300 engines per working shift. The original factory at Earlsfield was completed during 1947, when it had a shop-floor area of 120,000 sq. ft.; by 1950, this had become inadequate and plans for the extension and re-organisation of the production lines were prepared. The floor space has now been doubled, but, by the introduction of higher-capacity production methods, a reduction of idle stock between machines, better machining and sub-assembly, and the use of pallets and of overhead conveyors (to free floor area to the greatest effect), the capacity has been quadrupled.

It was appreciated from the beginning that such an increase in production could only be achieved by an entirely new layout, and it was apparent that the new production lines would have to be put down in the extension building, care being paid to maintain the continuity of production as adequate stocks could not be built up. As space became available in the original block, the equipment required for the new types of engine that were to be introduced was progressively laid down. The change-over, now complete, was effected without the loss of a single production shift, the transfer of machines being made during week-ends and holidays.

The new arrangements and machinery are illustrated in Fig. 1, herewith, Fig. 2, opposite, and Figs. 3 to 6, on page 16.

Simultaneously with the re-organisation of the production lines, the company have terminated the bonus incentive scheme that had been in operation for the shop employees. All employees are now paid at a flat hourly rate, incentive towards greater production being provided by a closely-controlled system of publicised targets, coupled with a regular review of individual employees' rates of pay and status, promotions being made where justified.

THE FACTORY BUILDING.

The factory at Peterborough stands on a site of 120 acres. In 1946-47, a production unit was built that included a main block, 600 ft. long by 200 ft. wide in ten 60-ft. bays, together with two smaller blocks, each 200 ft. by 60 ft., and housing the electrical-power distribution centre, castings-preparation shop, the canteen, stores and maintenance departments. An office block accommodated the administrative, clerical, accounts and production-control departments and the drawing offices. The extensions that have now been completed increase the width of the main block by 245 ft. This gives an effective increase in width to the shop floor of 200 ft., the other 45 ft. providing for a 20-ft. wide road through the block and giving cover to the factory heating plant, formerly outside the temporary east wall of the original factory. The general form of construction of the earlier block has been repeated in the extension, with the erection of ten bays each 60 ft. wide by 200 ft. long and having a full roof height to the apex of 40 ft. and 25 ft. high to the underside of the eaves. A heavier type of truss has been employed so that overhead conveyors can be slung from the new trusses without the need for additional supports from the floor. Extensions have also been made to each of the smaller blocks and their function modified. Thus, the castings-preparation shop has been extended by 3,500 sq. ft. and a balcony floor added, to be used for pipe-bending and hardening shops. Further office accommodation has also been added to the administration block.

The walls of the factory are 9 in. thick, with ample steel-framed windows; doors are automatically controlled wherever possible and are of a sliding or folding pattern to conserve space. Along the north side and part of the east side, cloakrooms and first-aid facilities have been provided at ground-floor level, with balconies carrying works offices above. Roofing is of corrugated asbestos sheeting, with glass on the north side of the trusses. Electrically-operated ventilators are fitted in each section of the roof, and all the asbestos sheeting is lined internally with an insulating board. To give maximum light in the shops, and to reduce eye-strain, the walls and stanchions, as well as the machines, are painted in light shades of green. In winter, electrically-driven fans circulate air, heated by gas burners, through overhead ducting; in hot weather, cool air is circulated through the same ducting. The floor of the extension is paved with wood blocks. Lighting is by high-pressure mercury-vapour lamps, supplied with three-phase current to prevent the stroboscopic effect associated with a single-phase supply. Tungsten lamps are also provided at intervals, to give instantaneous light in an emergency and to correct the yellow deficiency in mercury light.

The testing shop, with its power, water, fuel and exhaust services, is situated in the extreme south of the extension; noise isolation from the remainder of the factory, and ventilation of the test shop, can be improved by opening the sliding doors in the southern outside wall. No artificial heating is required in this shop, as the engines on test maintain it at a comfortable working temperature. The clocking-in racks are distributed round the factory according to the number of operators working in any part of the shops; by this means congestion is avoided at the beginning and end of working periods. Coats are at present left on floor-type racks, but it is intended eventually, to have racks which can be raised into the roof space, to free the floor.

FACTORY LAYOUT.

To facilitate reception and to reduce the movement of materials and components by delivering them directly on to the production lines, the layout has been designed symmetrically about the central roadway. Traffic on this roadway is one-way only from north to south, and is controlled from the goods-reception office at the north end. On either side of the roadway are the buffer areas, stores and inspection stations. The total holding of materials in the buffer areas has been planned on the basis of a minimum practicable stock, according to the nature of the items concerned.

On the production side of the inspection stations are the processing lines, lying at right angles to the central roadway and ending near the main assembly lines, which run along the side walls and parallel to the roadway; a general view of one of the main assembly lines is shown in Fig. 1. No stocks are held between machining and sub-assembly, and only a minimum between the ends of the processing lines and the main assembly lines. As far as possible, the process lines are so located that all components or sub-assemblies are delivered to the main assembly lines at the points at which they are required for building into the engine. To minimise handling and movement, sections or stores which serve more than one production block have been located between the blocks concerned. Standardisation has been developed to the full, but the diverse uses to which the engines are to be put often involves adapting standard engines to the requirements of individual customers. This has made it necessary to establish a general-purpose machining and engine-finishing department, shown in Fig. 5, on page 16. Components that are particularly liable to modification or alteration are the flywheel, the engine housing and the engine bearers.

MACHINE TOOLS AND METHODS.

The re-organisation has provided the opportunity to introduce machine tools and methods of the maximum productive capacity. Engine designs were re-examined and, where necessary, modified to reduce the number of operations required. The need for the highest economy in floor space was the criterion deciding between different processes or machines. Broaching has been adopted whenever possible; main bearing caps are cast in sticks of five, side by side, and much of the drilling and facing is completed before the caps are separated by broaching. Fig. 2, opposite, shows a machine broaching connecting rods and caps. The three machines on this and allied work occupy a total of only 300 sq. ft., and in so doing replace 15 milling and multi-spindle drilling machines that would have taken up 1,000 sq. ft. to perform the same operations at a comparable rate. Pneumatically-operated tooling has been chosen for most tasks, though hydraulic operation is used for certain jobs.

Machine tools have been acquired from a variety of sources, including both the United States and the Continent, as well as from the United Kingdom; though United Kingdom tools are preferred, the delivery dates quoted for some tools have driven the company into foreign markets. Most of the fixtures and tooling were designed in the works, including a large proportion of the multi-spindle

DIESEL-ENGINE WORKS OF F. PERKINS, LTD.

FIG. 1. A MAIN ASSEMBLY LINE.

DIESEL-ENGINE WORKS OF F. PERKINS, LTD.

FIG. 2. BROACHING CONNECTING RODS AND CAPS.

drilling fixtures, such as those illustrated in Fig. 3, on page 16, which drill and ream all the holes in the joint and combustion faces of the cylinder blocks simultaneously. Milling has been the subject of much development by the company and feed rates of the order of 20 in. per minute are now in current use, combined with a cutter life of 1,000 components before the tool is reground. Completely automatic transfer machines are another feature of the factory, the two largest together completing all the drilling and boring operations on a cylinder head; in these machines, 164 cutting tools are in action simultaneously. The introduction of the newer methods and of the re-organised layout has been found where a direct comparison can be made, to reduce labour requirements by 25 per cent. It is hoped that, when the plant is being worked to capacity, a reduction of nearly 50 per cent. will be achieved.

Before they pass to the sub-assembly stage, all components are thoroughly washed in an alkali solution, using high-pressure spray-washing machines. The fabrication of sub-assemblies is done as a continuation of the process line concerned and no buffer stock is carried between machining and fabrication. Power-operated tools and special sub-assembly carriers and fixtures are the general rule and selective assembly has been avoided by careful control of the tolerances at each manufacturing stage. From the sub-assembly lines, the components are fed into the main assembly line, which runs at right angles across the ends of the process and sub-assembly lines. Every engine is fully tested for performance and fuel consumption before despatch. The type of test brake mostly used employs an electrical generator as the load resistance, the power so produced being fed back into the shop mains. The test beds have been designed to accept any of the engines being made and are arranged in pairs; 25 such units have been installed. A general view of the test shop is shown in Fig. 6, on page 16. After testing, the standard engine goes to the finishing line, where the special parts required for any particular application are made and fitted. The completed engine is then spray-painted and sent to the finished store.

MATERIAL AND COMPONENT HANDLING.

The factory has been designed to eliminate wasteful handling. Delivery of components obtained from outside suppliers is made to the beginning of the appropriate process line, and many of the suppliers have been induced to use the same type of pallet as is used at Earlsfield; components are therefore delivered in the most convenient form for conveyance within the factory. Three standard box pallets have been decided upon, the two largest capable of containing a load of 1 ton and the smaller, ½ ton. Flat pallets of either wood or of steel are also in general use, and special pallets have been made for handling quantities of camshafts, copper water-manifolds, etc. Standard foot clearances allow for fork-lifting, and cup and spigot fittings at the bottom and top of the corner posts of each pallet facilitate stacking.

For unloading materials and for general transport about the factory, Diesel-driven fork trucks are used, having a capacity of 6,000 lb. Smaller fork trucks, battery-powered, are used to serve the process lines. For moving materials over longer distances, there is a fleet of tractors with platform trailers. Overhead conveyors have been installed at two points. One is at the acceptance point for the machined cylinder blocks, where an overhead conveyor is used to hold more than one day's supply in case of machine stoppages, and the other linking the end of the assembly lines with the test shop and the test shop with the engine-finishing line. Seven travelling transporters are available in the test shop for transferring the engine from the conveyor to the test bed and for returning the engines to the outgoing circuit. Additional overhead chain conveyors are to be installed to transport the rough cylinder-block castings to the process lines and to move completed engines through the spray-painting booths.

On all the major-component process lines, every endeavour has been made to ease the work of the operator. Machines and fixtures have been built to a common loading height, and fixtures are loaded by sliding the workpiece from the roller track between each machine; where the loading height does differ from the standard, air-operated lifting tables are provided. Turn-over fixtures, such as that shown in Fig. 4, on page 16, are used for changing the heavier components or assemblies from one face to another, and any lifting that is necessary is assisted by pneumatic cylinders. On the smaller component process lines, extensive use is made of gravity chutes for feeding the parts through successive operations. Elevated conveyors are used throughout for feeding machines, such as the broaching machines, where the working height is considerable.

In all, 380 existing machines were moved to new positions and 450 new machines were installed. Roller tracks totalling 4,000 ft. in length were provided, with all necessary turn-over fixtures gates and lifting sections; and 190 cranes, with supporting structures were required. Air-supply mains and connections, numerous fittings for electrically-operated hand tools, and many special foundations for machines also had to be provided. All the installation of new equipment and the resiting of existing machines was carried out by the works maintenance department, with no assistance from outside contractors.

MANUFACTURE OF COATED ABRASIVES IN BELFAST.—The Norton Grinding Wheel Co., Ltd., Welwyn Garden City, Hertfordshire, inform us that a new factory of their associate company, Behr-Manning, Ltd., is to be opened in Belfast, by Viscount Brookeborough, P.C., C.B.E., M.C., Premier of Northern Ireland, on July 6. The factory will produce sandpaper and other coated abrasives for the woodworking, metalworking, leather and other industries, and the Norton Company will act as distributors, in this country, for all Behr-Manning materials.

LAUNCH OF NEW TYPE OF FRIGATE.—H.M.S. Salisbury, the first of a new series of naval vessels, known as aircraft-direction frigates, was launched on June 25, at the Royal Naval Dockyard, Devonport. She has an overall length of 340 ft., a beam of 40 ft., and is propelled by Diesel engines of standard Admiralty design. Her armament comprises two 4·5-in. guns and two smaller guns. Powerful radar equipment is carried to enable the vessel to fulfil her main functions of giving warnings of the approach of hostile aircraft and of directing fighter aeroplanes to their targets. In all, four new types of frigate will be used by the Royal Navy: two for anti-submarine work, one for service against aircraft, and one for aircraft direction.

NEW OPTICAL SYSTEM FOR TELEVISION CAMERAS.—Marconi's Wireless Telegraph Co., Ltd., Chelmsford, in conjunction with the optical firm of Cox, Hargreaves and Thomson, have constructed an optical system for television cameras with an equivalent focal length of 80 in. and therefore capable of producing exceptionally large-scale images of distant objects. The system is similar to that employed in a reflecting telescope of the Cassegrain type and comprises a concave mirror having a central aperture and a smaller convex mirror in front of it which reflects the light back from the concave mirror through the central aperture to a focal plane behind the latter. The Cassegrain system has the advantage that the overall length required is relatively short, being only 20 in. in this case, and the weight is only about 20 lb.; also, since the light is reflected and not refracted, chromatic aberration is eliminated. We understand that the system was used on one of the cameras employed by the British Broadcasting Company for televising the recent Ascot races on June 18 and 19.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

CO-OPERATION BETWEEN TRANSPORT UNDERTAKINGS.—Mr. A. T. Lennox-Boyd, Minister of Transport, in a written answer in the House of Commons on June 22, announced that the possibility of closer working arrangements between British Railways, Scottish Omnibuses, and the Glasgow Corporation Transport Department is to be investigated as a matter of urgency by a committee under the chairmanship of Sir Ian Bolton. The Railway Executive have been asked to consider and report on the possibility of making progress in the near future with the main recommendations of the Inglis Report, relating to railway electrification and reconstruction schemes. The Executive have also been requested to prepare a scheme for the introduction of a service of multiple-unit Diesel train sets to operate between Glasgow and Edinburgh. British Railways, moreover, have been asked by the Scottish Chambers of Commerce to inquire into the possibility of introducing a fast Diesel-electric train connection on the Glasgow-Prestwick railway line. The central committee of the Chambers of Commerce propose that Monkton railway station should be used, pending the incorporation of a main-line station in new airport buildings. They are of the opinion that Prestwick should become an international airport, and that, to achieve this, it is necessary to expedite surface transport between Prestwick and Glasgow.

COVERED WATER RESERVOIR AT PARKHEAD.—Parkhead Reservoir, near Glen Village, Stirlingshire, which will serve the Falkirk, Laurieston, and Polmont districts, was officially opened on June 17. The reservoir, which is roofed over, has a storage capacity of 2,000,000 gallons.

NEW ELECTRICITY SUBSTATIONS AT GIRVAN.—The South-West Scotland Electricity Board have approved of a scheme, estimated to cost 20,127*l.*, for the reinforcement of their network in Girvan. This will be effected by a changeover in the operation of the network from 3,300 volts to 11,000 volts. Four new outdoor substations will be constructed.

FACTORY FOR LIGHT ENGINEERING PRODUCTS, EAST KILBRIDE.—Work has started on a site at Nerston, East Kilbride, where a factory is to be built for Hayward Tylor & Co., of Luton, mainly for the production of mineral-water bottling plant and small steam turbines. The factory is to be built under the direction of Scottish Industrial Estates, Ltd., and the Development Corporation are providing the necessary roads and other services.

BARONY POWER STATION, AYRSHIRE.—The British Electricity Authority have received consent from the Minister of Fuel and Power to the building of a power station at Cumnock, Ayrshire. To be known as Barony power station, it has been designed to burn slurry and filter-cake residues from coal-washing operations at the adjoining Barony Colliery. The plant will consist of two 30,000-kW turbo-generator sets, steam being provided by four boilers, each evaporating 150,000 lb. per hour. The station is one of a series to be built near to collieries rather than consuming centres, to produce electricity from low-grade coal.

CLEVELAND AND THE NORTHERN COUNTIES.

HEATON LOCOMOTIVE SHEDS, NEWCASTLE.—British Railways are carrying out extensive alterations to the locomotive sheds at Heaton, Newcastle-on-Tyne. The sheds are 80 years old. The alterations are being carried out in three stages. The first stage is complete, the second is in hand and the whole project will be finished within 12 months.

WELDING IN SHIPBUILDING.—Addressing members of the Sea and Air Port Health Authorities at their annual meeting at Sunderland, Mr. C. Stephenson, director and general manager of William Doxford and Sons, Ltd., shipbuilders, said that no British welded ships had been lost through breaking their backs. Cases of faults in welded ships, chiefly tankers, were nearly always due to other reasons, such as bad loading. Welded ships lost through breaking in two had all been foreign vessels. Mr. Stephenson said that, encouraged by the example of the United States during the late war, the method of prefabrication in association with electric welding had been adopted and had been found to be technically and economically suited to adoption on a large scale.

RECONSTRUCTION AT OLD HARBOUR, HARTLEPOOL.—The Docks and Inland Waterways Executive have accepted the tender of John Howard & Co., Ltd., civil-engineering contractors, Howard House, Buckingham Gate, London, S.W.1, for the reconstruction of the lightening berth at the Old Harbour, Hartlepool. It is understood that the total cost of the scheme will be about 300,000*l.*

THE LATE MR. R. B. CHARLTON.—The death has occurred at Hexham, Northumberland, of Mr. Robert Blackett Charlton, proprietor of the firm of R. B. Charlton, Ltd., brassfounders and engineers, Newcastle-on-Tyne. He was 101 years of age, and retired from active business 30 years ago.

LANCASHIRE AND SOUTH YORKSHIRE.

APPRENTICES SCHOOL FOR WAGON WORKS.—British Railways are establishing a new school for apprentices at Earlestown Wagon Works, Lancashire, the largest railway-wagon and container works in this country. The works require a normal complement of 176 apprentices, and the purpose of the school is to attract sufficient trainees of the desired calibre, to give them a twelve months course of preliminary practical and theoretical instruction, and to select individual apprentices for the skilled crafts for which they show the greatest aptitude, the overall training period to a particular trade occupying five years. The school will provide facilities for 40 boys at a time and will consist of a workshop, classroom, instructors' room, stores and amenities. An existing works building is to be adapted to accommodate the school, and the reconstruction work will commence this month. It is expected to be ready for use early in 1954.

THE COAL SITUATION.—South Yorkshire coal merchants state that they are not receiving sufficient supplies of house coal to permit of building up stocks for the winter. They are also asking for a larger proportion of the better grades of coal. The stocks of industrial steam coals are lighter than is usual at this time of the year. A miners' demonstration, at Doncaster, on June 20, made it impossible to work the Saturday shift, and this resulted in an estimated loss of over 60,000 tons of coal.

NUMEROUS ORDERS FOR PEWTER.—An exceptional situation has arisen in the old pewter industry of Sheffield, where the demand is greater than it has been for a quarter of a century, due to strong pressure from America. Manufacturers are unable to accept all th orders offered. One firm have refused two orders, each of a value of 1,000*l.*

AUSTRALIAN IMPORT QUOTAS.—Members of the Sheffield Chamber of Commerce have been told that Australian import quotas may be enlarged this year, possibly by October 1. The information has been given by Mr. S. F. Ferguson, director of the Australian Association of British Manufacturers, who foreshadowed that Sheffield manufacturers would have to fight to regain their Australian markets when trade restrictions were modified. Australian manufacturers, he said, were exerting pressure on the Government not to abolish restrictions completely, but to revise tariffs to make Australian goods competitive.

THE MIDLANDS.

FERGUSON TRACTOR EXPORTS INCREASING.—Messrs. Harry Ferguson, Ltd., Coventry, announce that the number of Ferguson tractors dispatched to export markets during May was the highest for any month so far this year. Since January, when 2,312 Ferguson tractors were sent overseas, the company's exports have risen steadily to the May figure of 3,932. To keep pace with this increasing demand, the rate of production at the Standard Motor Company's Banner-lane factory, Coventry, where the tractors are built, has twice been increased in recent months and is now running at about 240 a day. The volume of Ferguson tractor exports to Scandinavian countries has been particularly remarkable. In May, Norway, Sweden and Denmark took more than 1,000 between them. Iceland, an unexpected market for tractors, took 57, and another 31 are being shipped there during June. Canada, an important dollar market, took 250; more than 700 were exported to Australia during May; New Zealand took 250; and 312 were sent to countries in Africa. The assembly of tractors in France by the new Standard-Hotchkiss Company is now well under way and more than 700 new machines left the factory outside Paris during the first three months of operation.

SPRING FACTORY AT WEST BROMWICH.—A new factory for the manufacture of road-vehicle springs was opened at West Bromwich, Staffordshire, on June 19, by Brigadier A. R. Low, M.P., Parliamentary Secretary to the Ministry of Supply. The factory, which is on a newly developed site in Birmingham-road, is owned by Richard Berry and Son, a subsidiary of J. Brockhouse & Co., Ltd., West Bromwich. The company already have a spring works at Smethwick.

TECHNICAL COLLEGE EXTENSIONS.—A decision by the Ministry of Education to exclude from the 1954-55 building programme the second instalment of the extensions to the Chance Technical College at Smethwick, Birmingham, is now in abeyance. A deputation from the County Borough of Smethwick has visited the Ministry, and, as a result, there are to be further discussions between the local authorities and the Ministry. The College serves a highly-industrialised area on the Smethwick-Birmingham borders.

ELECTRICITY ON FARMS.—Alderman W. S. Lewis, chairman of the Midlands Electricity Board, commenting on the recent Government decision to increase the amount of money available for rural electrification, said in Birmingham on June 21 that the Board will take full advantage of the increased allocation. Alderman Lewis said that the exact amount of money available to the Midlands Board could not be stated at present, since the total sum of 1,500,000*l.* had to be shared by 14 area boards. He added that the Midlands area of supply contained about 26,500 farms, of which about half were at present without mains electricity.

FACTORY HEALTH CENTRE.—A new health centre, costing 10,000*l.*, has been opened at the Darlaston, Staffordshire, engineering works of Rubery, Owen & Co., Ltd. The centre, which has taken a year to build, is four times the size of the previous building.

SOUTH-WEST ENGLAND AND SOUTH WALES.

SINKING OF PITS BY GERMAN FIRM.—It has been announced by the South Western Divisional Coal Board that negotiations are proceeding with a German firm for the sinking of pits at Cynheidre, five miles north-west of Llanelly. This is a major scheme of reorganisation and development in the anthracite area. An official of the Board has stated that the contract was likely to be placed with this firm because they were the only contractors who had the highly-specialised equipment and labour needed for sinking pits to the depth required, in the type of strata occurring in the locality. The Board were also influenced by the fact that the number of contractors in pit-sinking operations in Britain were limited and that such contractors were already fully engaged in various British coalfields. Pit-sinkings for which British contractors had the requisite equipment were likely to be put in hand before long in the Neath area of the South Wales coalfield.

INDUSTRY IN BUILTH WELLS.—The East Wales district committee of the Welsh Board for Industry, who had decided to investigate the possibility of securing a light-engineering industry for Builth Wells, have been told that, because the town was not in the South Wales Development Area, no inducement could be offered to industrialists. It was pointed out, moreover, that unemployment in Builth Wells, last March, was only 27 and that this had since fallen as low as 13.

ABERGAVENNY-BRECON ELECTRICITY-TRANSMISSION LINE.—To supplement electricity supplies in Breconshire, work has been proceeding on a 66,000-volt line from Abergavenny to Brecon. The line has been designed so as to be suitable for extension to Llandrindod Wells at a later date.

SWANSEA TO BIRMINGHAM HIGHWAY.—Mr. Gurney Braithwaite, Parliamentary Secretary, Ministry of Transport, has announced in Parliament that plans are being prepared for road improvements, with diversions near Abergavenny, which will form part of the principal route from Birmingham to Swansea. Plans for a bridge over the River Severn and a by-pass to Newport are also in course of preparation.

AMERICAN TANKERS TO BE BROKEN UP.—Two American tankers have recently arrived at Newport Docks to be broken up. One, the Massachusetts, of 6,828 tons gross, was towed across the Atlantic from Mobile by the Canadian ocean-going tug Foundation Lillian, and the Dutch tug Noord Holland towed the Arkansas, of 6,452 gross tons, to Newport. Both ships were previously owned by the Texas Company, of Wilmington, U.S.A., and have been purchased by the British Iron and Steel Corporation.

LAUNCHES AND TRIAL TRIPS.

M.S. "RUDOLF ANDERSSON."—Single-screw oil tanker, built and engined by Eriksbergs Mekaniska Verkstads A/B., Gothenburg, for Rederi A/B Bifrost, Gothenburg, Sweden. Main dimensions: 526 ft. by 69 ft. 9 in. by 39 ft. 4 in.; deadweight capacity, 18,125 tons on a draught of 30 ft. 4½ in. Eriksbergs-B. & W. nine-cylinder heavy-oil engine, developing 9,000 i.h.p. Speed, 15½ knots. Trial trip, June 4.

S.S. "CALTEX BAHRAIN."—Single-screw oil tanker, built and engined by R. and W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne, County Durham, for Overseas Tankship (U.K.), Ltd., London, W.1. Main dimensions: 544 ft. 4 in. overall by 70 ft. by 39 ft. 9 in. to upper deck; deadweight capacity, 17,450 tons. Double-reduction geared steam turbines, developing a maximum of 8,200 s.h.p., and two Yarrow marine boilers. Speed, 15 knots. Trial trip, June 6.

M.S. "MAID OF ARGYLL."—Twin-screw vessel, with accommodation for 650 passengers, built by A. and J. Inglis, Ltd., Glasgow, for the Scottish Region of British Railways, for service on the Clyde. Second of three similar vessels for the Scottish Region. Main dimensions: 165 ft. overall by 28 ft. by 10 ft.; displacement, 420 tons. Two Diesel engines constructed by British Polar Engines, Ltd., Glasgow. Speed, 15 knots. Trial trip, June 6.

S.S. "HARPA."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, for the Anglo-Saxon Petroleum Co., Ltd., London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft. to upper deck; deadweight capacity, about 18,000 tons. Double-reduction geared steam turbines, developing 7,500 s.h.p. in service; and two Babcock and Wilcox oil-burning boilers, constructed by the ship-builders. Trial trip, June 9 and 10.

M.S. "BONANZA."—Single-screw cargo vessel, with accommodation for 12 passengers, built and engined by Götaverken A/B, Gothenburg, Sweden, for A/S Ganger Rolf (Managers: Fred Olsen & Co.), Oslo, Norway. Main dimensions: 511 ft. 3 in. by 63 ft. 6 in. by 40 ft.; deadweight capacity, 9,530 tons on a draught of 26 ft. 11½ in. Götaverken nine-cylinder marine oil engine, developing 8,200 b.h.p. Speed, 17 knots. Trial trip, June 10.

M.S. "SAMOA."—Single-screw cargo vessel, with accommodation for 12 passengers, built and engined by Burmeister & Wain, Ltd., Copenhagen, for the East Asiatic Co., Ltd., Copenhagen, Denmark. Main dimensions: 456 ft. between perpendiculars by 62 ft. 6 in. by 29 ft. 6 in. to second deck; deadweight capacity, 9,944 tons on a draught of 26 ft. 4 in. B. and W. seven-cylinder single-acting two-stroke Diesel engine, arranged for burning boiler or Diesel oil and developing 9,800 i.h.p at 115 r.p.m. in service. Speed, about 16·8 knots. Trial trip, June 15.

M.S. "JERSEY SPRAY."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for Morel, Ltd., London, E.C.3. Main dimensions: 420 ft. between perpendiculars by 57 ft. 9 in. by 28 ft. 6 in.; deadweight capacity, 9,100 tons on a draught of about 26 ft. Four-cylinder opposed-piston oil engine, developing a service speed of about 13 knots. Trial trip, June 17.

M.S. "ALVA STAR."—Single-screw oil tanker, built by Sir James Laing and Sons, Ltd., Sunderland, for the Alva Steamship Co., Ltd. (Managers: Navigation and Coal Trade Co., Ltd.), London, E.C.3. Main dimensions: 512 ft. between perpendiculars by 72 ft. 6 in. by 41 ft. 2 in.; deadweight capacity, 18,340 tons on a draught of 30 ft. 6½ in. Six-cylinder opposed-piston heavy-oil engine, constructed by William Doxford and Sons, Ltd., Sunderland. Speed, 15 knots. Trial trip, June 17 & 18.

M.S. "NORDEFIC."—Single-screw trawler, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for the North Eastern Fish Industries, Ltd., Newfoundland. Main dimensions: 105 ft. by 23 ft. 6 in. by 11 ft. 6 in. Diesel engine developing 450 b.h.p. at 310 r.p.m., constructed by Crossley Brothers, Ltd., Openshaw, Manchester. Speed on trial, 10·3 knots. Trial trip, June 24.

M.S. "NESSBANK."—Single-screw cargo vessel, built and engined by Harland and Wolff, Ltd., Belfast, for the Andrew Weir Shipping and Trading Co., Ltd., London, E.C.3. Second vessel of a series of six. Main dimensions: 425 ft. between perpendiculars by 59 ft. by 38 ft. 3 in. to shelter deck; gross tonnage, about 5,800. Harland-B. and W. six-cylinder single-acting crosshead Diesel engine. Trial trip, June 24.

M.S. "TEESWOOD."—Single-screw cargo vessel, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the Constantine Shipping Co., Ltd., Middlesbrough, for service on the St. Lawrence River and the Great Lakes, Canada. Main dimensions: 214 ft. 6 in. between perpendiculars by 35 ft. 4 in. by 16 ft.; deadweight capacity, about 1,560 tons on a draught of 15 ft. 8½ in. Five-cylinder oil engine, developing 800 b.h.p. at 250 r.p.m., made by British Polar Engines, Ltd., Glasgow. Speed, 10½ knots. Launch, June 25.

BRITISH STANDARD SPECIFICATIONS.

THE following publication of engineering interest has been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 24, Victoria-street, London, S.W.1, at the price quoted in the text.

Steel and Aluminium-Alloy Nuts and Bolts for Aircraft.—Seven new specifications in the aircraft-materials series, Nos. A.102-108, have just been issued. They cover a range of bolts and nuts, of ¼ in. nominal size and above, with UNF (Unified Fine) threads and with hexagon dimensions agreed for aircraft use between representatives of the British, Canadian and American services and industries. This new series of hexagon sizes differs from that of the normal series of Unified precision hexagon screws and nuts for general engineering purposes, covered by B.S. No. 1768: 1951, in providing common dimensions for the hexagons of the bolts and nuts of the same nominal size, and in the dimensions of the hexagons for ⅜-in., ⅞-in. and 1-in., nominal size bolts and nuts. The numbers, titles and prices (including postage) of the seven specifications are as follow: A.102, steel bolts (Unified hexagons and UNF threads) for aircraft [4*s.*] A.103, steel nuts (Unified hexagons and UNF threads) (ordinary, thin, slotted, and castle) for aircraft [3*s.*] A.104, corrosion-resisting steel bolts (Unified hexagons and UNF threads) for aircraft [3*s.* 6*d.*] (The corrosion-resisting steel involved is that covered by specification No. S.80 and is a 55-ton minimum ultimate tensile stress high-chromium-nickel steel.—ED. E.) A.105, corrosion-resisting steel nuts (Unified hexagons and UNF threads) (ordinary, thin, slotted, and castle) for aircraft [3*s.*]. A.106, aluminium-alloy bolts (Unified hexagons and UNF threads) for aircraft [3*s.* 6*d.*]. A.107, aluminium-alloy nuts (Unified hexagons and UNF threads) (ordinary and slotted) for aircraft [2*s.* 6*d.*], and A.108, steel bolts (Unified hexagons, UNF threads and close-tolerance shanks for aircraft [3*s.*]. In all cases clauses relating to material and manufacture, freedom from defects, dimensions, tolerances, and identification and marking are included. Various tests are also stipulated and methods of conducting these are furnished.

CONTRACTS.

THE ENGLISH ELECTRIC CO. LTD. announce that the English Electric Export and Trading Co. Ltd. have received an order from the U.S. Army Corps of Engineers for ten 103,300-kVA, 230-kV, continuously-rated, single-phase, outdoor-type power transformers for the Chief Joseph Dam. The transformers are for connecting in three 310-000-kVA three-phase banks, ratio 230 kV/13·2 kV (one transformer is a spare). The 230-kV winding is designed for star connection (neutral grounded) in the three-phase banks. Each transformer will have an externally-operated off-circuit tap changer on the high-voltage winding. They will be forced-oil cooled, the oil being cooled by water through a heat exchanger.

PALMERS HEBBURN CO. LTD., Hebburn-on-Tyne, have received a contract from the Admiralty for converting the Ulster-class destroyer Ursa into an anti-submarine frigate. The work will be carried out at the firm's Jarrow yard, where a similar task is being completed on the destroyer Whirlwind.

JOHN LEWIS AND SONS, LTD., Aberdeen, have obtained orders from the West Hartlepool Steam Navigation Co., Ltd., to build four Diesel-engined trawlers, each 100 ft. in length. The propelling machinery will be supplied by CROSSLEY BROTHERS, LTD., Manchester. Another contract is for a 200-ft. pontoon dock, for the Aberdeen Harbour Commissioners.

VICKERS-ARMSTRONGS LTD., Walker, Newcastle-upon-Tyne, have received an order from Alfred Holt and Co. Ltd., for a cargo liner of 9,000 tons deadweight carrying capacity. Four similar vessels are already on order for these owners. The new ship will be propelled by a John G. Kincaid–B. and W. Diesel engine giving a speed of 15½ knots.

A. AND W. SMITH AND CO. LTD., sugar-machinery manufacturers, Glasgow, have secured a contract from the Pakistan Development Corporation for the machinery for a complete factory capable of dealing with 1,200 tons of sugar cane a day. The value of the contract is about 500,000*l.*

FERGUSON BROS. (PORT GLASGOW), LTD., Port Glasgow, have received an order for a twin-screw steam tug from the Government of Nigeria. The propelling machinery will comprise triple-expansion engines designed and manufactured by the builders. The vessel is for service in Port Harcourt.

LOBNITZ & CO., LTD., Renfrew, have obtained an order from the Government of the Union of Burma, for three self-propelled cutter suction steam dredgers, each 134 ft. long by 29 ft. broad by 8 ft. deep. The vessels will be shipped in sections to Burma.

PERSONAL.

SIR MICHAEL BARRINGTON-WARD, a member of the Railway Executive since its inception and formerly divisional general manager of the London & North Eastern Railway, is retiring on October 1.

Following upon the retirement of MR. P. CROOM-JOHNSON, C.B.E., M.I.C.E., chief engineer, London Transport Executive, on June 20, MR. C. E. DUNTON, M.A. (Cantab.), M.I.C.E., at present civil engineer, has been made chief civil engineer; MR. A. C. EDRICH, A.M.I.C.E., at present permanent-way engineer (railways), has been appointed assistant civil engineer (permanent way); and MR. T. S. PICK, B.Sc.(Eng.) (Lond.), M.I.E.E., M.Inst.F., at present electrical engineer, has been appointed chief electrical engineer.

The Fairey Aviation Co. Ltd., Hayes, Middlesex, announce that by arrangement with the Ministry of Supply, they have appointed BRIGADIER J. CLEMOW to be head of guided-weapon development at their research and armament development division.

MR. W. H. PURDIE, director and general manager of the engineering department of William Doxford and Sons Ltd., Pallion, Sunderland, is retiring on November 30, but will retain his seat on the board. MR. ARTHUR STOREY, a director of the North Eastern Marine Engineering Co. (1938) Ltd., Wallsend, joined Messrs. Doxford on July 1 as a director and deputy manager of the engineering department. He will succeed Mr. Purdie as general manager on November 30.

MR. L. H. PULFER has succeeded the late MR. R. A. DEANS as manager of the special-lamp department of the British Thomson-Houston Co. Ltd., Crown House, Aldwych, London, W.C.2.

MR. CLIFFORD COLE and MR. WILLIAM TOVEY have relinquished their appointments on the board of Warne, Wright and Rowland Ltd., screw manufacturers, Keeley-street, Watery-lane, Birmingham, 9.

MR. C. METCALFE, A.M.I.P.E., has been appointed managing director of E.M.I. Engineering Development Ltd. He was elected a director of the firm in May, 1946.

MR. J. B. MILES, for the past 15 years chief engineer to Cincinnati Milling Machines Ltd., Birmingham, is joining Alvis Ltd., Holyhead-road, Coventry, as chief production engineer early in July.

MR. STEPHEN BAKER, M.A.(Cantab.), has been appointed service manager of Davy and United Engineering Co. Ltd., Park Iron Works, Sheffield, 4.

PEST CONTROL LTD. have decided that the growth of their business is such that the board should consist predominantly of full-time directors. As a consequence, MR. A. B. BARRIE and MR. F. V. WALLER are not seeking re-election and MR. D. H. SCOTT and MR. W. J. PARKER have tendered their resignations. DR. PARRY JONES has joined the board as a full-time director

MR. D. N. DOW, B.Com., has been appointed secretary to the National Gas and Oil Engine Co. Ltd.

MR. HUGH E. EASTON, chief accountant to Johnson and Phillips Ltd., Charlton, London, S.E.7, retired on June 30.

The title of the INSTITUTE OF ECONOMIC ENGINEERING has been changed to the SOCIETY OF INDUSTRIAL ENGINEERS, 28, Victoria-street, London, S.W.1.

The public-relations department of the SHELL PETROLEUM CO. LTD. is now at Victory House, 99-101, Regent-street, London, W.1. (Telephone REGent 0531.)

NEWMAN INDUSTRIES LTD., Yate, Bristol, have removed their London office to Terminal House, Grosvenor-gardens, S.W.1. (Telephone: SLOane 8206.)

THE BOLINDERS CO. LTD., Coronation House, 4, Lloyd's-avenue, London, E.C.3, announce that they have concluded an arrangement with NYDQVIST & HOLM, Trollhättan, Sweden, under which they are able to handle inquiries for new machinery and spare parts for Nohab and Polar Atlas Swedish Diesel engines.

On and after August 15, the address of the sales office of the ALUMINIUM WIRE AND CABLE CO. LTD., will be 30, Charles II-street, St. James's-square, London, S.W.1. (Telephone: TRAfalgar 6441-6.) The present address is in Thurloe-street, S.W.7.

MUSGRAVE & CO. LTD., St. Ann's Works, Belfast, have removed their Bristol office to 1, Host-street, Bristol, 1. (Telephone number, namely, Bristol 23369, is unchanged.)

THE HERCULES POWDER CO. LTD., 40, Park-lane, London, W.1, have concluded an agreement to act as sole distributors, for the United Kingdom, of Akulon, a polyamide (nylon) type of injection and extrusion moulding material manufactured by ALGEMENE KUNSTZIJDE UNIE, N.V., Arnhem, Holland.

On July 6, the HOFFMANN MANUFACTURING CO. LTD., Chelmsford, Essex, are opening a branch on Tees-side, at 176, Newport-road, Middlesbrough.

RE-ORGANISATION OF A DIESEL-ENGINE WORKS.

F. PERKINS, LTD., PETERBOROUGH.

(*For Description, see Page* 12.)

FIG. 3. MULTI-SPINDLE DRILLING AND REAMING HEADS.

FIG. 4. TURN-OVER GRAB ON AN ASSEMBLY LINE.

FIG. 5. GENERAL MACHINING SECTION.

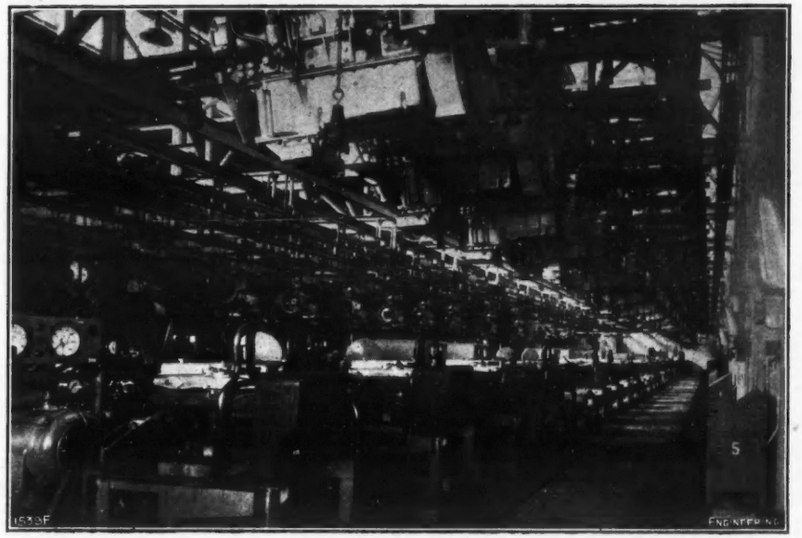


FIG. 6. TEST SHOP.

ENGINEERING.

35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and any other publication bearing a similar title.

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Telephone Numbers:
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ADVERTISEMENT RATES.

Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Monday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 16 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks left in their possession for more than two years.

INDEX TO VOL. 174.

The Index to Vol. 174 of ENGINEERING (July-December, 1952) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, copies of the Index are being distributed only in response to such applications.

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ENGINEERING

FRIDAY JULY, 3, 1953.

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AMERICAN PRODUCTION OF AMMUNITION.

THE production of armaments is a serious business or an outrageous business, according to individual viewpoint or mood; but much less easy to classify is the fact that, after a British productivity team had visited the United States in 1952 to study American methods and organisation in the production of ammunition—a "top secret" subject, it might be supposed—they published their detailed findings for all the world to read. If the ultimate aim of armament production is, indeed, to achieve supremacy in that field a certain reticence in broadcasting the way to success would not be unexpected. Why, then, this lack of reticence? The answer would appear to strike at the root of all the productivity team reports, suggesting that neither British industry nor any other nation's industry can hope to gain much from them directly. The teams generally have sought explanations for the disparities in productivity by focusing attention on basic factors such as management, workers' response to incentives, education and the like. They have quickly realised that a report which concentrated on the end effects of these factors would be valueless, and they have therefore attempted to examine the train of causes and effects at a much earlier point. It is as though, when confronted with an example of high American productivity, they have asked "Why is this so?" and have continued to put the same question to one answer after another until, eventually, they reached the spheres of "top management," traditional outlooks in the two countries, and even the psychological make-up of the peoples. Not having the facilities to delve deeper into these themes, the teams have expounded their subjects at this level. A reader of the reports, however, may not be content to stop there; he may feel that only after asking the inquisitive question once more will the most interesting findings emerge.

If a team of French politicians visited this country and reported back on the basic merits of the unwritten British Constitution, they would be told, rightly, that, while their report was interesting, it had no direct application to French politics, the histories of the two nations being different. Similarly, the industries of the United States and Great Britain have quite different historical growths. Both use generally similar equipment—machine tools, furnaces, contractors' plant, etc.—but the factors which, in the last analysis, account for differences in productivity are the intangibles which Britain have quite different historical growths. history has thrown up.

Though it would be quite impracticable for the productivity teams themselves to undertake research into the basic historical causes of present-day productivity in this country, such a task should be attempted. It would reveal the origins of present shortcomings, and it would discuss them objectively, instead of comparatively in relation to American industry. A paragraph in the recently published report of the productivity team on ammunition* refers to the indefinable national characteristics to which most of the teams have drawn attention: "The American regards himself as an individual and a real person with sovereign rights in the target he sets himself in life. He does not build a fence round his garden for privacy, and he talks to you in the train, or while driving your taxi, about his job, his life, and in fact about human relations and getting together." As showing the importance which productivity teams attach to management rather than to the tools of production, the following sentence is representative: "We certainly came to realise as we went along that in regard to this matter of productivity the study of Americans and their attitude to their own management was even more profitable than a study of the tools and equipment in the plants we visited."

The productivity team on ammunition was led by Brigadier E. Merrill Ransford, chief inspector of armaments, Ministry of Supply, and the team secretary was Colonel W. Paget Careless, military assistant to the Deputy Controller of Supplies (Munitions Production), Ministry of Supply. The other 12 members were drawn from various Royal Ordnance Factories, the Ministry of Supply, and industrial firms. The proposed terms of reference were: to study (1) the organisation of ammunition design, procurement, production, inspection and packaging; (2) typical plants, both in arsenals and industry, with particular reference to functional organisation; planning; production; inspection, test and proof; training of supervisors and operators; and industrial relations; (3) shop-floor management, and the processes and techniques, particularly where labour-saving is achieved, affecting production and inspection; and (4) contractural obligations in respect of quality. As the programme and itinerary for the team were only received on the day before they left England, there was no time to suggest alterations. The team subsequently found that a more suitable itinerary could have been arranged. In particular, in view of the importance attached by the United States Government departments to the adequate use of "small business" in a re-armament programme, the team regretted that they were not given an opportunity to visit at least one small plant.

* *Ammunition: Report of a British Productivity Team on Ammunition, which Visited the United States of America in* 1952. British Productivity Council, 21, Tothill-street, London, S.W.1. [Price 5*s.*, including postage.]

The report is in two parts, the first presenting a general review of American organisation, principles and practice, and the second being a study of the production of certain types of ammunition and components, in which some techniques, applicable, perhaps, to other industries, are described. In their main recommendations the team stress some of the factors which impressed them. The detailed planning and "engineering" for production which were undertaken in the preparatory stages, before production commenced, were noticeably thorough, and great attention was given by the Americans to the reduction in indirect labour and in the fatigue of direct labour by the use of conveyors and other mechanical aids. The cost involved was thought to be justified by the large size of the contracts and the high rate of production; nevertheless, the team believe that the British industry could profitably extend its use of similar methods. Detailed planning and plant engineering, however, require a high level of administrative ability in all managerial grades. Administrative ability, it is pointed out, should be regarded as a qualification distinct from, though preferably combined with, acquired technical knowledge and skill. Greater attention should be paid to such ability in the selection of individuals for appointment or promotion to the lower grades of managerial responsibility "as a first step towards responsibilities of a wider nature."

In the United States the recognition of a need for "introducing a common understanding of the basic fundamentals of inspection, thus resulting in a better understanding of the reasons for inspection," led to the publication of a manual, *Introduction to Procurement Inspection*, and also to standard procedures, including sampling systems. The team recommend that a study should be carried out in this country of the means whereby the policy and procedure of the supply organisation, i.e., procurement, production and inspection, can be more closely integrated and co-ordinated.

The present piece-work system in the United Kingdom, it is stated, leads to many anomalies. It does not necessarily provide the intended incentive, and wage "inequities" are often created which cause unrest. The team believe that the application of the American system might contribute to increased productivity, and that it should be studied accordingly by British employers and trade unions. The team observed the American application of job description, classification and evaluation methods associated with task work on a time-work basis—a system which is being used extensively in the United States. The subject of apprentice training in this country is criticised by the ammunition team, as it has been by previous teams. They recommend that the system should be examined with a view to establishing basic standards and conditions of training, and to the award of a standard certificate for satisfactory completion of apprenticeship with any registered employer whose training scheme conforms to the standards laid down. This recommendation arose from the favourable impression the team formed of the American approach to the problem of increasing the number of skilled men and of raising the standard of education and training on which increased productivity must so largely depend.

Of the team's other recommendations, the final one harks back to the fundamental issue. They praise the sustained efforts of the American workman, and they believe that, apart from other factors, the high standard of productivity in the United States must be dependent to a major extent on the belief which he has in the certainty of the rewards for enterprise and in the need for efficient and economical employment of his labour. They therefore conclude that this attitude should be encouraged in any measures which may be considered for adoption in the interests of productivity in the United Kingdom.

PROGRESS IN BRITISH HYDRAULICS RESEARCH.

BARELY eight months have passed since the Hydraulics Research Board issued the report which reviewed their work from the date of their appointment in November, 1946, to the end of 1951, so that the recent publication of the report* for 1952 represents a commendable and successful attempt to bring the record up to date. It is especially satisfactory as an indication of the progress made in the construction of the new national hydraulics research station at Howbery Park, near Wallingford, Berkshire. In reviewing the previous report of the Board, in our issue of December 26, 1952 (vol. 174, page 825), we mentioned the completion there of a wave tank in which the effect of seawalls on beaches was to be studied. The present report records that, in addition, a wave basin—the first of two—was completed in June last year, and will enable investigations to be made of the combined effect of waves and tides; in which connection it may be noted that Dr. A. T. Doodson, F.R.S., the Director of the Liverpool Tidal Institute, was one of three new members appointed to the Board during the year. The other two were Mr. W. E. Doran, O.B.E., M.I.C.E., chief engineer of the Great Ouse River Board, and Colonel R. H. Edwards, M.I.C.E., civil engineer for the South Wales Docks (East) in the Docks and Inland Waterways Executive. These three new appointments were in place of Sir Geoffrey Taylor, F.R.S., Mr. W. P. Shepherd Barron, M.I.C.E., and Mr. W. H. Haile, O.B.E., M.I.C.E., who retired from the Board on completion of their respective periods of service.

"Wave Basin I," referred to above, is 125 ft. long, 80 ft. wide and 2 ft. 6 in. deep. A second, Wave Basin II, has also been completed so far as the structure is concerned, but, within the period covered by the report, was still awaiting its pumping equipment. It is of the same main dimensions as Wave Basin I, but is being provided with means to study coastal currents. Other apparatus which became available during the year included a channel 12 ft. wide and a flume 5 ft. wide, both 350 ft. long and 2 ft. 6 in. deep, intended to be used for basic research into the effect of discharge and charge of material on the regime shapes and slopes of channels. In addition to these, the workshops and service laboratories were completed in September and have been equipped with various machine tools, etc.; and work was started on the main building, to house large models. The first part of this building, now being constructed, covers an area of 300 ft. by 200 ft. The roof columns being 100 ft. apart, it will be possible to construct models of the largest size under cover. These developments have enabled the concentration of the staff at Wallingford to be continued steadily, so that, at the end of last year, only five of the technical staff of 42, and three out of 18 "industrials" (to adopt the Director's term) remained in the tidal-model shed at Teddington, which has been lent to the Board by the National Physical Laboratory, pending the completion of the Howbery Park establishment.

The report of the Director, Sir Claude Inglis, C.I.E., M.I.C.E., which is appended to the Board's report and, in fact, occupies the larger part of the complete publication, contains a good deal of supplementary information on the River Wyre and River Eden investigations, which were described in the previous report and summarised in our review of it. There are, however, many other researches recorded, which show how important a place is being taken by the new establishment. The large model of the Thames from Teddington to the Nore, which was constructed on the Royal Albert Dock estate for the Port of London Authority, and described and illustrated in ENGINEERING of February 1, 1952 (vol. 173, page 139), is dealt with in considerable detail, as are the additional studies—not all carried out on the main Thames model—on means for excluding silt from the Surrey Commercial Docks and from the tidal basin at Tilbury. The original pilot model of a part of the Thames, which also was referred to in our article in February of last year, has been used to examine the behaviour of material carried in suspension, by the injection of granulated Perspex.

One of the most important investigations was that of the changes reported to be taking place in the configuration of the banks and channels in Morecambe Bay. This was undertaken at the request of the Railway Executive, who were directly concerned as successors to the London Midland and Scottish Railway in the operation of channel steamers from Fleetwood and Heysham to Ireland and the Isle of Man. The harbour at Heysham is connected with the deep water of Heysham Lake by a short channel which was cut in 1904, when the harbour was constructed. The required depth of water in the channel was maintained without difficulty by dredging until the construction, in 1940-42, of a jetty for oceangoing tankers, and this jetty was suspected of causing the progressive reduction which was reported in 1950 in the depth of water in the Lake. Investigation showed, however, that, in addition to the changes constantly occurring in the whole of Morecambe Bay, the area bounded by the Old Grange Channel and Heysham Lake was subject to long-term cyclic fluctuations, with a periodicity of about 120 years, and that the conditions were approaching their worst state. If dredging were undertaken to correct the progressive shallowing, the cost would be excessive, as the dredged portion would be refilled from Morecambe Bay; whereas, if the cycle were allowed to proceed normally, the conditions might be expected to improve. It is concluded that "the continued usefulness of the port appears to be assured," if the conditions which obtained a century ago are adequate to the needs of future traffic.

Another research of some magnitude has been undertaken for the Lyttelton Harbour Board, New Zealand, into the possibilities of the designs that have been prepared for extending the present harbour, situated about 4½ miles from the sea in the inlet known as Port Lyttelton. This inlet has a soft clay bed which slopes from the beach at its head, 8 miles from the sea, to the mouth. The sides of the inlet are formed by steep cliffs, so that waves entering from the sea are not refracted, but can travel into the harbour, where they cause "considerable disturbance." To examine the possible liability to silting and "ranging" in the proposed new harbour, two models have been built in Wave Basin I at Howbery Park, the smaller being a model of the whole inlet to a horizontal scale of 1 : 600 and a vertical scale of 1 : 100, on which both waves and tides can be reproduced; and the larger, a section of Port Lyttelton in the neighbourhood of the harbour. This second model, which has a horizontal scale of 1 : 180 and a vertical scale of 1 : 90, will be used to study wave action; but it can only reproduce waves with a periodicity corresponding to a full-scale period of 76 seconds, and therefore the smaller model will be used to study the effect of waves of longer periods, up to 4 minutes.

These examples are only a few instances of the varied and valuable work carried out during 1952 under the aegis of the Hydraulics Research Board, and recorded in a report that must make interesting reading to any engineer who possesses an inquiring mind, whether or not he is directly concerned in that particular branch of civil engineering or the instrumentation associated with it.

* *Report of the Hydraulics Research Board, with the Report of the Director of Hydraulics Research for the Year* 1952. H.M. Stationery Office, York House, Kingsway, London W.C.2. [Price 6s. net.]

NOTES.

PARIS INTERNATIONAL AIR SALON.

DURING the past week the 20th Salon International de l'Aéronautique has been in progress at Le Bourget airport, Paris. The exhibition, which is organised by the Union Syndicale des Industries Aéronautiques, was opened on Friday, June 26, by the President of the French Republic, M. Auriol, and it remains open until Sunday, July 5. This is the first year that the exhibition, which was inaugurated in 1909, has been held at the airport, and a new exhibition hall has been specially constructed to house the display of models and equipment, which hitherto had been shown in the Grand Palais in Paris, separate from the flying display. Some 160 exhibitors, from Belgium, France, Holland, Italy, Luxembourg, Spain, Sweden, the United Kingdom and the United States are displaying their products. Outside, some 40 aeroplanes and helicopters from seven different countries are on view. On June 27, the emphasis was on the sporting aspect of aviation, and light aircraft, touring aeroplanes and sailplanes were demonstrated on the ground and in flight. June 28 was devoted to commercial aviation, and visitors had the opportunity of examining the most recent aircraft in service with the regular air-lines. From June 29 to July 1, an international congress was held, the main theme of which was the production of airframes. Tomorrow, July 4, after an official luncheon, a flying display of French and other prototype aircraft will be given before an invited audience. It will be followed by demonstrations of parachute jumping aerobatics, and a fly-past of jet aircraft of the North Atlantic Treaty Organisation air forces. This programme is to be repeated on Sunday July 5, when the public will be admitted.

TECHNICAL EDUCATION IN 1952.

The latest report of the Ministry of Education, which was published by H.M. Stationery Office last week, under the title *Education in* 1952, gives a great deal of statistical and other information regarding the work which was done in the primary, secondary and "further" fields of education. In June of that year the Government announced their proposals for improving facilities for higher technological education, and accepted the recommendations of the National Advisory Council on Education for Industry and Commerce in favour of increased financial assistance for selected colleges and courses. As a result, the rate of grant for certain types of advanced courses and research work in technical colleges was raised from 60 to 75 per cent. and was made applicable to capital as well as to maintenance expenditure, thus providing, it is hoped, substantial encouragement to local education authorities to improve their facilities for study at the highest level. It is reported that the effects of the substantial building programmes sanctioned in 1949 and later were beginning to be apparent, although in many areas conditions regarding accommodation deteriorated, a state of affairs which was acerbated by the post-war increase in the number of students. In 1951-52, the total number of full-time students was 54,017, a slight increase over the figure of the previous year, thus indicating, it is considered, that the permanent demand for full time courses is steadily rising. As the result of representations from the Leicestershire Local Education Authority, the Ministry agreed to take over responsibility for the engineering and science sides of Loughborough College from September 1, 1952, on the grounds that this establishment formed an important part of the national provision for the training of engineers and that curtailment of its activities which were no longer purely local, especially at the present time, would be undesirable. It is noted that the College of Aeronautics is now firmly established and is supplying the industry with well-trained technologists Particulars are also given of a new scheme of training for marine engineers. This consists of a two-year full-time course in a technical college, which leads to an Ordinary National Diploma in mechanical engineering and is followed by 18 months training in sea-going vessels and one year in a marine engineering works ashore. In this way it is hoped to overcome the difficulty of attracting suitably qualified men to marine work. The price of the report is 5*s*.

VISIT TO THE STAFFORD AND PRESTON WORKS OF THE ENGLISH ELECTRIC COMPANY.

At the invitation of the English Electric Company, Limited, Queens House, Kingsway, London, W.C.2, a large party of overseas visitors, distinguished engineers and Government officials, from many parts of the Commonwealth and some foreign countries, paid a two-day visit of inspection on Monday and Tuesday, June 22 and 23, to the company's works at Stafford and Preston. Leaving London in a special train on Monday morning, the guests, on arriving at the Stafford Works, were welcomed by the chairman, Sir George Nelson, who briefly explained the activities and general policy of the firm, and were then taken on an extensive tour of the shops, where they were able to see many water-driven and steam turbo-alternators, transformers, and other heavy electrical equipment in course of construction. The Nelson Research Laboratories, which were illustrated and described in ENGINEERING, on page 56 of vol. 165 (1948), were also inspected. Leaving Stafford in the late afternoon, the guests proceeded to Southport, where a reception and dinner, at which Sir George Nelson presided, were given in the Palace Hotel. On the following morning the guests were taken to Preston and in a tour of the company's Preston works were able to see something of the firm's activities in the fields of rail and road traction and aviation. The latter was most effectively demonstrated in a flying display by a Canberra aircraft at Salmesbury Aerodrome, to which the guests were taken before returning to luncheon at Preston. After luncheon the guests returned to London by the special train, all being fully appreciative of the hospitality of the company and greatly impressed by the part it is playing in maintaining the prestige of the British engineering industry in face of severe competition. The only possible regret could be that time did not permit a similar tour of the several other establishments of the organisation, all of which are guided by the same standards as influence the personnel of the Stafford and Preston works and have been set up by the chairman and his board of directors.

THE INSTITUTION OF CIVIL ENGINEERS.

The Institution of Civil Engineers have announced the following awards for Papers published in the December, 1951, *Journal* and the *Proceedings* for 1952: a Crampton Prize to Mr. P. A. Scott, B.Sc., M.I.C.E. (London), for his paper "A 75-in. diameter Water Main in Tunnel: A New Method of Tunnelling in London Clay," and Telford Premiums to Professor W. T. Marshall, Ph.D., B.Sc. (Eng.), M.I.C.E. (Glasgow) and Dr. Chun Nung Noo, B.Sc. (North China), jointly, for their paper "An Experimental Investigation of the Stresses in Angle Brackets"; to Mr. E. S. Crump, C.I.E. (Wallingford, Berkshire), for his paper "A New Method of Gauging Stream Flow with Little Afflux by Means of a Submerged Weir of Triangular Profile"; to Professor J. F. Baker, O.B.E., M.A., Sc.D., M.I.C.E., (Cambridge) and Dr. J. W. Roderick, M.A., M.Sc., A.M.I.C.E. (Sydney, Australia), jointly, for their paper "Tests on Full-Scale Portal Frames"; to Dr. P. W. Rowe, A.M.I.C.E. (Manchester), for his paper "Anchored Sheet-Pile Walls"; to Mr. Z. S. Makowski, Dip.Ing. (London), for the joint paper by himself and Professor A. J. S. Pippard, M.B.E., D.Sc., M.I.C.E. (London), on "Experimental Analysis of Space Structures, with Particular Reference to Braced Domes; with a Note on Stresses in Supporting Ring-Girders." The special thanks of the Institution have been accorded to Professor Pippard as, being a member of Council of the Institution, he is not eligible for an award; and to Mr. F. J. Samuely, B.Sc. (Eng.), A.M.I.C.E. (London), and Mr. P. J. A. Ward, A.M.I.E.E. (London), for their paper on "The Skylon." The special thanks of the Institution have also been accorded to Mr. J. A. Banks, O.B.E., M.I.C.E. (Glasgow), for his paper on "Problems in the Design and Construction of Knockendon Dam"; Mr. Banks, being a member of Council, is not eligible for an award.

ELECTRONICS EXHIBITION AT MANCHESTER.

Professor Sir Geoffrey Jefferson, C.B.E., F.R.S., formerly of the University of Manchester, will open the eighth annual electronics exhibition of the Institution of Electronics at the College of Technology, Sackville-street, Manchester, 1, at 2.30 p.m. on Wednesday, July 15. An endeavour has been made by the North-West Branch of the Institution, which is responsible for the organisation of the exhibition, to cover as wide a field as possible, and to interest large sections of the general public as well as members of the professions, and technicians from many branches of science and industry. The exhibition will be divided into two parts, consisting of a scientific and industrial research section, with displays by universities, hospitals and similar bodies, and a commercial section, devoted to manufacturers' producrs, which will include exhibits from more than 50 commercial undertakings. In the research section, there will be demonstrations of television transmitting and receiving equipment, constructed by members of the Television Society; radio transmitters and receivers, constructed by members of the Radio Society of Great Britain; and a spectrum analyser, designed by the radio experimental and development branch of the General Post Office. The principles of colour television will be demonstrated on equipment exhibited by Messrs. Ferranti, Limited; and the principles and practice of electro-acoustics on apparatus supplied by the British Sound Recording Association. Many exhibits in this section will be devoted to medical applications of electronics. A series of about 50 lectures, dealing with many branches of electronics, and including some of general interest, as well as others of a specialised character, will be delivered during the course of the exhibition. Film displays will take place three times daily. Except on Sunday, July 19, the exhibition will remain open each day until Tuesday, July 21, from 10 a.m. to 10 p.m., but will close at 7 p.m. on July 18, and at 9 p.m. on July 21. Admission to the exhibition and the lectures will be by ticket only, obtainable from Mr. W. Birtwistle, 17, Blackwater-street, Rochdale, Lancashire. Catalogues will also be available, price 1*s*. 6*d*. each, including postage.

AMALGAMATION OF THE MINISTRIES OF TRANSPORT AND CIVIL AVIATION.

Further details of the proposals for the amalgamation of the Ministry of Transport and the Ministry of Civil Aviation, which the Prime Minister, Sir Winston Churchill, announced in the House of Commons on February 26 last, are contained in a White Paper (Cmd. 8883, H.M. Stationery Office, price 2*d*. net), published on June 24. This change has been under consideration since the formation of the present Government and a preliminary step was taken by the appointment of the same Minister for the two Departments. Later, an additional Parliamentary Secretary was appointed, under the Minister, and given special responsibility for civil-aviation matters. The Government propose that two Parliamentary Secretaries, one for transport generally and one for civil aviation in particular, shall continue to be appointed in the combined Ministry, which will be known as the Ministry of Transport and Civil Aviation. A draft Order in Council will be laid before the two Houses of Parliament, providing that the amalgamation shall take place on October 1, next. It is stated in the White Paper that the proposals are put forward in pursuance of the Government's constant aim to simplify the machinery of government and the reduction of its cost. The main tasks of reviving civil aviation in the United Kingdom after the war, and determining the broad lines of its future development, in both the national and international fields, the White Paper continues, have been carried to a stage where the subject no longer requires the undivided attention of a separate

Minister. The balance of advantage now lies in a closer association of civil aviation with the older forms of transport, under a single Minister and in one Department. All parts of the unified Ministry will be organised in such a way as to permit of rapid adaptation, in emergency, to defence needs. The amalgamation will make possible a limited measure of staff economies, through the integration of common services, and there may be scope for small savings in accommodation.

BRITISH COAL UTILISATION RESEARCH ASSOCIATION.

A new research building for the study of domestic appliances was substantially completed a few months ago at the Leatherhead Research Station of the British Coal Utilisation Research Association, and was formally opened on June 24 by Sir John Charrington, vice-President of the Association. With the opening of this building the Research Station is now practically complete and its activities are concentrated instead of being carried on in improvised quarters. Research on the utilisation of solid fuel in domestic appliances is a subject which has a wide appeal. Tests are being conducted into the smoke emission and radiant heat from different coals burnt in the modern type of free-standing open fire with a restricted chimney throat. Tests are also being undertaken to determine the efficiency of, and the heat radiated by, a banked fire; for this series of tests the grate is mounted on a continuously recording scale. In the tests on domestic-type grates, radiation temperatures are measured by thermocouples which are mounted on a framework placed in front of the grates, the temperatures being electrically recorded on charts. Other sections of the laboratory are studying the efficiency of central-heating systems. A forced-circulation system, resulting in an important degree of simplification and a reduction of installation costs, is under development, and two calorimeter rooms have been provided for measuring the room-heating efficiency and the heat given off by different appliances. Since the activities of the Research Station were described in ENGINEERING (vol. 171, page 762, 1951), much progress has been made. The burning of fine coal by the cyclone method has progressed, and in conjunction with the Department of Industrial and Scientific Research effort is now being directed towards developing a coal-fired gas-turbine. A pilot plant for producing a gas of the necessary cleanliness and temperature is under test, but a solution of the problem of the carrying-over of volatile and inorganic matter, which leads to bonded deposits in turbine blades, is still being sought. In the field of gas-producer practice, effort is being directed towards reducing tar deposition in mains, maintaining level beds in producers by mechanical means, and obtaining higher calorific values either by using modified blasts or by modifying design. Studies have also been made of the mechanism of smoke formation and destruction, the mechanical properties of coal, and the structure of coal by X-ray diffraction. A pilot rig has recently been brought into operation for studying the fundamentals of pulverised-fuel combustion.

INFORMATION ON CONSERVATION OF RAW MATERIALS.

A list of sources of information in Austria, France, Germany, Italy, Sweden, and the United Kingdom, on research into the conservation of raw materials, has been compiled by a sub-committee, for co-operation in scientific research and technical development, of the Organisation for European Economic Co-operation. The list consists of a collection of standard sheets each devoted to a particular subject, giving names and addresses of persons or organisations from which detailed information can be obtained. The sheets can be consulted at, or borrowed from, the Technical Information and Documents Unit, Cunard House, 15, Regent-street, London, S.W.1. The principal materials and techniques on which work is being done include building materials, cellulose, corrosion, fuels, glass fibre, iron and steel, non-ferrous metals, ores, paper and board from straw, plastics for plumbing, rubber, sulphur, leather, textiles and wood.

LETTERS TO THE EDITOR.

DECENTRALISATION OF BRITISH RAILWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—In the leading article on page 753 of your issue of June 12, though welcoming the abolition of the over-centralised administration of the Railway Executive under the recent Transport Act, you advocate the retention of the engineering policies for which that body has been responsible, on the grounds of technical improvements and economies effected by standardisation. This contention shows so complete a disregard of the facts, as seen from an independent standpoint, that I am amazed at the success of the propaganda dispensed by the Railway Executive in misleading so shrewd an authority as yourself.

No engineer could afford to ignore the economies offered by standardisation, but these are of course only realised if the equipment selected is of the soundest possible design. Whether this proviso is realised in the case of British Railways' standardised equipment is, on the basis of the facts known to the public, very much open to doubt. Take the range of locomotives, for example. Loud as he is in praise of the performance of the "Britannia" class in East Anglia, even that well-known supporter, Mr. Cecil J. Allen, is noticeably less vocal concerning that of the remaining seven types. The excellence of this performance becomes largely illusory when one recalls that, prior to the appearance of the "Britannia" in 1951, engines of comparable power and weight were barred from these lines on account of safety considerations. One can but hope that this lowering of safety standards will not lead to any more accidents such as those at Weedon and Blea Moor (and more recently to the steamer Princess Victoria), which, according to the Ministry of Transport inquiries, were due primarily to engineering errors.

Turning from the performance to the design of the standard locomotives, reports of a number of faults emerge. The Railway Executive has already admitted troubles due to driving wheels twisting on the axles. Mr. Allen finds the cabs, the subject of so much fraternising and collaboration between the Executive and the trade unions, draughty and dusty due to faulty aerodynamic design. The reversing mechanism has a habit of jamming in full-gear. There is apparently grave wastage of water in the tank engines when running bunker first, due to the omission of anti-surge valves on the tanks, and so on. None of these faults is incurable, it is true, but under the standardised system which you so strongly advocate, instead of being confined to one type of locomotive, each is immediately perpetuated on all the others. They are, moreover, exactly what one would expect when political dogma dispenses with the services of four experienced chief mechanical engineers, having in the aggregate some dozens of successful designs between them.

On the facts before us, therefore, far from wishing to continue the present system, many of us see in the Transport Act a unique opportunity for re-introducing those standards of design and safety for which Britain's railway engineers were formerly so rightly famous.

Yours faithfully,
R. G. B. GWYER,
M.A., A.M.I.Mech.E., A.M.I.E.E.

The Limes,
11, Windsor-road,
Clayton Bridge,
Manchester, 10.
June 15, 1953.

TO THE EDITOR OF ENGINEERING.

SIR,—While I was most interested to read the leading article "Distant Signal" in your issue of June 12, I feel that the writer, in his desire to praise the work of the Railway Executive, has rather confused the issue, and is labelling as "technical improvements" certain tasks in which the engineering sections of the Executive have shown considerable adroitness in making something out of a very awkward job. The Executive had a clear mandate from the British Transport Commission to standardise engineering equipment on a national basis, and the mandate came at a time of financial stringency, of material shortages, and labour difficulties following the end of the most fearful war in history. The Executive had to do something, quickly, with next to no financial backing.

What they have done towards the process of fulfilling their mandate is considerable, but one could not call it "technical improvement." Take the standard locomotives as an example: a mixed-traffic engine of "Class 7" capacity was needed, to suit conditions anywhere in the country; the Executive produced a "Pacific" with a large boiler, wide firebox, and only two cylinders. It weighed 94 tons, against the 80 to 84 tons of existing 4-6-0 engines of similar load ratings built by the old companies, and still capable of first-class service. That decrease in the power/weight ratio is not "technical improvement"; it is the price we have to pay for a standard locomotive to meet modern conditions anywhere in the country.

Reverting to your issue of June 12, however, would it be possible for your leader-writer to enumerate at least some of the "many technical improvements" he had in mind? One gets so used to the jargon of the popular press, in which phrases like "technical developments" are employed when "skill in improvisation" or other administrative adjustments are really meant, that one hopes that there was more behind your article than mere journalistic whitewash. Perhaps you could also enlarge on the rather ambiguous statement that: "Most of the technical developments which have taken place in the past 4½ years *could* not have been achieved by the four former railway companies." (The italics are mine.)

Yours faithfully,
O.S.NOCK, M.I.C.E., M.I.Mech.E.

20, Sion-hill,
Bath.
June 19, 1953.

[In view of the recommendations of the Lemon Committee on Standardisation, it would be surprising if these two letters were typical of engineering opinion on the standardisation of railway equipment. The main point of the leading article (and of a previous article in the issue of June 5) was that standardisation of rolling stock, even without an increase in the purely mechanical or thermodynamic efficiency, is sound policy on British Railways because it permits a greater degree of flexibility in the operating and commercial departments. These are the departments which serve the customers, working under difficult labour and materials-supply conditions. Both correspondents have ignored this argument; Mr. Nock, apparently, because he finds that the power-to-weight ratio of a certain class of standard locomotives is not as favourable as the ratios for the corresponding locomotives of the former railway companies. The vital point which must be settled within the next year or so, under the terms of the Transport Act, 1953, is the nature and extent of decentralisation to be introduced on the main-line railways. Mr. Nock only confuses a discussion on this many-sided problem by focusing attention on one among innumerable factors.

When the railways were nationalised on January 1, 1948, there were 448 different classes among the 20,000 steam locomotives taken over (even the 1,200,000 wagons comprised only 480 types). Surely it will be a major technical improvement if the Railway Executive (or their successors) can effect a reasonable reduction in the number of types. Between 1948 and 1950, before any of the standard engines had appeared, the cost of locomotive repairs had been reduced from 8·026*d.* to 7·220*d.* per mile for repairs in the main works, and from 4·390*d.* to 4·066*d.* per mile for running-shed work; this at a time when wages and materials costs were rising. A further reduction in the number of locomotive types will facilitate further savings in years to come. These are technical developments. An alteration in the power to weight ratio, in the thermal efficiency or any purely engineering concept is not significant to the railways until its total effect on railway work is assessed. Most of the technical developments which have taken place in the past four and a half years are of a kind which could only have been carried out by a national organisation. They include, apart from standardisation of rolling stock, tests on existing bogies to evolve the most satisfactory design; the laying-down of plant for the quantity production of carriages (on a scale greater than a single railway company could have attempted);

a reduction in the number of lubricating oils used in the motive-power departments from 93 to 9; the standardisation of locomotive limits and fits; economies in the use of non-ferrous alloys; and the co-ordination of locomotive testing facilities and experience. There have, of course, also been technical developments of a kind which might have been introduced by one or more of the railway companies.

Mr. Gwyer instances faults in the design of the standard locomotives. Faults were also made in some of the designs of the four railway companies. In any case, it is clearly cheaper to alter, say, ten prototype locomotives if the subsequent order is for, say, 400, than if it is for 100.

In the leading articles referred to we endeavoured to view the question of decentralisation of the railway engineering departments as a whole, and in its relation to the efficiency of railways in serving industry and the public. This is more important and more subtle than a view restricted to the mechanics, etc., of locomotive design.—ED., E.]

OBITUARY.

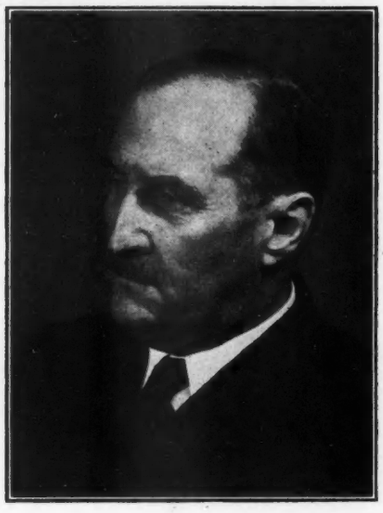
DR. ROBERT SULZER.

IT is with much regret that we have learned of the death on June 19 of Dr. Robert Sulzer, as the result of a heart attack, in his office at the works of Sulzer Brothers, Limited, Winterthur, Switzerland Dr. Sulzer, who was 80 years of age, was an engineer of eminence in many fields, but especially in the development of heavy-oil engines for marine propulsion, in which his firm were among the pioneers. The leading position which they have occupied in this branch of engineering for nearly half a century was due in no small measure to his personal efforts.

He was second son of Heinrich Sulzer-Steiner, for many years the head of Sulzer Brothers, Limited, and may fairly be described as a born engineer. After attending secondary and technical schools in Winterthur and in Lausanne, and spending three years in the Sulzer works, he studied mechanical engineering at the Swiss Federal Institute of Technology (better known, perhaps, as "the Polytechnic") in Zürich, where he took his diploma in 1898. A year as assistant to Professor Aurel Stodola, of that Institute, was followed by practical training at various engineering works in the United States and in England and by voyages to Japan and India. In 1901 he entered the family business, in which he was a partner from 1906 until 1914, when it was converted into a limited liability company, and subsequently, until 1941, a member of the committee of managing directors. Retirement, however, could only be a relative term to such a man as Sulzer, and to the end of his days he was a valued adviser, closely associated with all the activities of the firm.

As a young man, he was deeply interested in design, particularly of steam engines and pumps, but the workshops and foundries were his especial interest, and it was in these that he exerted his strongest influence towards the consistent maintenance of high standards of quality in combination with clear and simple design. His talent for the ingenious solution of mechanical problems was always guided by an innate sense of what was sound and practicable, which was greatly aided by a remarkable memory for detail that enabled him to make the fullest use of accumulated experience. At the same time, he was always open to receive suggestions and test innovations, and he took a keen pleasure in the provision of well-lighted and modern workshops. After the death of his elder brother, Carl Sulzer-Schmid, he was responsible for many years for the technical developments in most branches of the company's many activities; for instance, it was due to his own outstanding and untiring work that the Sulzer weaving loom was perfected and placed on the market.

Robert Sulzer's services were widely sought outside of his own company. He was a member of many Swiss technical committees and official bodies, and delivered numerous papers in England, France and Holland. Among them may be mentioned the classic paper on "Temperature Variations and Heat Stresses in Diesel Engines" which he delivered in 1926 before the Institution of Naval Architects, at their Spring Meeting in London, for which he was awarded the Gold Medal of the Institution; and another, read before the same Institution in 1930, on "Causes and Prevention of Vibration in Motor Ships." He was elected a member of the Institution in 1925, and for many years had acted as their honorary corresponding member in Switzerland. In 1933, also, he delivered a paper on "Welding for Pressure Vessels" to the Institute of Marine Engineers. In 1941, the degree of D.Sc., *honoris causa*, was conferred upon him by the Swiss Federal Institute of Technology in recognition of his many contributions to engineering development.



THE LATE DR. ROBERT SULZER.

Robert Sulzer's life outside the engineering field was many-sided. He was instrumental in the erection of many hundreds of modern homes for workpeople. He attained the military rank of colonel of a Swiss cavalry regiment. His leisure hours were spent in his workshop at home or with a camera. Of imposing stature and impressive personality, he was a born leader of men, who respected and valued the human qualities and the work of his employees and took a profound interest in their social welfare. They, in return, held him in the highest esteem and affection as an engineer and as an exponent of the best features of a family tradition.

MR. JAMES McGREGOR.

WE regret to learn, also, of the death in Glasgow, on June 20, of Mr. James McGregor, D.S.O., M.I.C.E., Mr. McGregor, who was born in 1878 at Houston, Renfrewshire, received his early technical training at the Royal Technical College, Glasgow, and, later, first as a pupil and then as an assistant, under the late Mr. Gilbert Thomson, M.A., M.I.C.E. His next appointment, still in Glasgow, was as chief assistant to Mr. C. C. Lindsay, M.I.C.E., who was, at that time, between 1903-06, engaged on designs for harbour works at Penang and Singapore. During 1906, following his election to associate membership of the Institution of Civil Engineers, Mr. McGregor emigrated to Canada, where he later acted as resident engineer on extensions to the Grand Trunk Pacific Railway and on the construction of the North Saskatchewan River Bridge. Between 1912 and 1916, he acted first as resident engineer and later as superintending engineer-in-charge at the Ocean Terminal Docks, Halifax, Nova Scotia.

In 1916, with the rank of major, Mr. McGregor served in France as Chief Engineer in command of the 3rd Battalion of the Canadian Railway Troops and was awarded a D.S.O. On his return to Canada in 1919, he resumed his duties at Halifax and was transferred to full membership of the Institution. During the early 1920's, Mr. McGregor returned to the United Kingdom where he worked with Messrs. Stewart and McDonnell in London on the design of harbour works for Takoradi and Accra in the Gold Coast. During 1925, he was chief engineer on the trunk road from New Tyndrum to Ballachulish, through Glencoe. Later, in 1933-34 he spent a further period in Canada on dock and harbour works on the Atlantic coast, before returning to his native Scotland to become a director of the Modern Construction Company, Limited, 86, St. Vincent-street, Glasgow. Besides membership of the Institution of Civil Engineers, Mr. McGregor was also a member of the Institution of Structural Engineers and of the Institution of Engineers of Canada.

CHEMICAL ENGINEERING CONFERENCE.

WITH the object of diffusing information regarding the aims and achievements of the British chemical engineering industry as widely as possible, the Institution of Chemical Engineers and the Chemical Engineering Group of the Society of Chemical Industry are jointly organising a chemical engineering conference, to be held at Olympia, London, W.14, during the period of the 19th Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition. The conference will be open to all persons attending the exhibitions, without fee or prior registration, and no tickets will be required. The sessions will take place during the afternoons of Monday to Friday, September 7 to 11, inclusive, commencing at 2.30 p.m., except on September 9, when the session will begin at 3 p.m. Papers to be read on September 7 will comprise "Carbon and Graphite as Materials of Construction for Chemical Plant," by Mr. A. W. Morrison, Mr. B. W. Freedman and Mr. P. G. R. Haines; and "Tantalum and Zirconium: Production and Properties," by Dr. G. L. Miller. Papers to be taken on September 8 will be "Developments in the Production of Chlorine, with Special Reference to Mercury Cells," by Mr. L. R. Thomas; and "Recent Advances in Milk-Processing Plant," by Mr. J. E. F. Renton. On September 9, there will be a discussion on "British Chemical Engineering," which will be opened by Sir Harold Hartley, F.R.S., and Mr. J. Grange Moore. This discussion will be based on the O.E.E.C. report on "Chemical Apparatus in the United States" and on the report on "Heavy Chemicals," published by the Anglo-American Council on Productivity. Papers to be presented on September 10 will be "Recent Developments in Evaporation, with Particular Reference to Heat-Sensitive Liquids," by Mr. B. N. Reavell; and "Recent Advances in Distillation," by Mr. G. A. Dummett and Dr. P. V. Clifton. Those to be delivered on September 11 will comprise "The Production of Formaldehyde from Methanol by the Silver Catalyst Process," by Mr. K. Nickels; and "Recent Developments in the Application of Plastics to Chemical Plant," by Mr. Verney Evans. Copies of the programme and further information respecting the conference may be obtained from the general secretary, the Institution of Chemical Engineers, 56, Victoria-street, London, S.W.1. Advance copies of the papers will not be available.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—The Council of the West of Scotland Iron and Steel Institute, 39, Elmbank-crescent, Glasgow, C.2, have awarded Riley Medals to Mr. R. P. Towndrow, M.Sc., for his paper, "Blast-Furnace Operation at High Top Pressure," and to Mr. R. Bowman, for his paper, "Some Practical Notes on the Casting of Ingots for Seamless Tube Making." Mr. Towndrow's paper was reprinted in our columns in volume 171, pages 575 and 607 (1951), and a later contribution on page 266 of our issue of February 27, 1953. Mr. Bowman's paper will be found on page 286 of our February 27, 1953, and page 381 of the March 20, 1953, issues.

THE ROYAL AGRICULTURAL SHOW, BLACKPOOL.

THE Royal Agricultural Society's Annual Show is due to open this year at Blackpool on Tuesday, July 7, and will remain open until the evening of Friday, July 10. Although this will be the first time for the Show to be held at Blackpool, it will be the ninth time the Royal has been to Lancashire, having been staged at Liverpool in 1841, 1877 and 1910, at Manchester in 1869, 1897, 1916 and 1930, and at Preston in 1885. With this year's visit, Lancashire will have acted as host to the Royal Show more times than any other county. It has been suggested that, in view of the high cost of staging the Show at a new location each year, namely, about 150,000*l.*, the Society should change its tactics and concentrate on forming a small number of permanent showgrounds at strategic points close to large centres of population. By taking its Show round the country, however, the Society is able to fulfil one of its chief objects, which is, the spreading as widely as possible of information on agricultural developments.

The amount of work entailed in staging the annual Royal Show is, possibly, not fully realised. At Blackpool, for example, constructional work started last September, while planning had begun many months earlier. Preliminary work, which was carried out by the Blackpool Corporation, included the levelling of 59 acres of land and the removal of 5,000 tons of rubble and nearly a mile of hedges or fences. Approximately 17,000 tons of soil were moved in the process of filling hollows and re-seeding 71 acres of the showground and car parks. The provision of water and electricity services, the erection of the sheds, pavilions, temporary roads, telephone services, etc., and the work carried out by the individual exhibitors, all form part of the necessary preliminary work and obviously constitute a task of great magnitude.

The Show is being held on the site of the old Stanley Park Airport, which is situated some two miles from the sea front. The showground, roughly rectangular in shape, covers approximately 140 acres, with a similar area nearby arranged for car parks. In general, this year's Show will follow fairly closely the pattern of its predecessors with something of interest for almost everybody. Prize money offered by the Society totals 20,000*l.* for about 700 classes of livestock, produce, riding, etc. Approximately 3,500 stock entries have been received in some 377 classes, this figure being slightly above that for last year's Show before foot and mouth disease caused cancellation of the cloven-hoof classes. There will be 20 breeds of cattle, 29 of sheep, 10 of pigs, and four heavy-horse breeds. This year there will be a poultry section, the incidence of fowl pest having caused this section to be cancelled from 1950 onwards. Commercial stands for machinery, equipment, supplies and services will total 620, compared with 570 for last year, and will occupy an area of about 1,200,000 sq. ft.

As previously mentioned, there will be something of interest to almost everybody. The social life of the countryside, for example, will be reflected in a "Village Green," a grass enclosure around which will be grouped the stands of some of the organisations such as the young farmers' club that cater for the spare-time activities of rural dwellers. Exhibits on the stand of the Rural Industries Bureau will demonstrate a wide variety of rural crafts which by no means are dying out. Among educational exhibits in other parts of the ground will be the Milk Marketing Board's stand where the collection of milk by tanker from the farms will be featured. Recent developments in the technique of sugar-beet cultivation will be demonstrated by the British Sugar Corporation and home-grown produce displayed and packed for market will be seen in the exhibition staged by the N.F.U. Market Produce Society. The main theme of the Ministry of Agriculture's exhibit will be "High Milk Output Per Acre," and the outdoor crops grown on the site will illustrate the correct methods of producing and using grass and fodder crops to achieve this aim. This section will include exhibits showing the value of strip grazing; an arable silage mixture undersown with Italian ryegrass to extend the grazing season; methods of making high dry-matter silage; and hay-making with the use of tripods. The "fixed" equipment will include an example of the conversion of an old cowshed into a modern milking "parlour."

There is a natural tendency this Coronation year to compare present-day achievements with those of the first Elizabethan era, but such comparisons can serve little real purpose, particularly in the field of agriculture where the introduction of mechanisation coupled with modern scientific methods of farming have completely altered the picture. These two factors have already contributed greatly to the solution of the problem of world food shortage and in the future will undoubtedly play a still more important part. Many examples can be quoted: on the scientific side, for instance, there are the introduction of artificial manures and fertilisers, improved seed strains and selective weed killers to mention but a few, while on the mechanical or engineering side there are the combine harvesters, grass-driers, and forage harvesters, in the development of which the Royal Agricultural Society has played an important part, and, above all, the ubiquitous tractor. The introduction of one new piece of equipment, however, frequently leads to developments in other directions. The evolution of the small, low-priced combine harvester, for instance, has led to an increasing use of this type of machine and this, in turn, has necessitated the provision of means for storing and drying the grain. As a consequence, there is a move towards setting up central storage and drying stations, a tendency that will be reflected at the Show by the number of silos and drying plants on view.

ROYAL AGRICULTURAL SHOW, BLACKPOOL.

FIG. 1. MODEL M4 "UNIVERSAL" TRACTOR; NUFFIELD ORGANISATION.

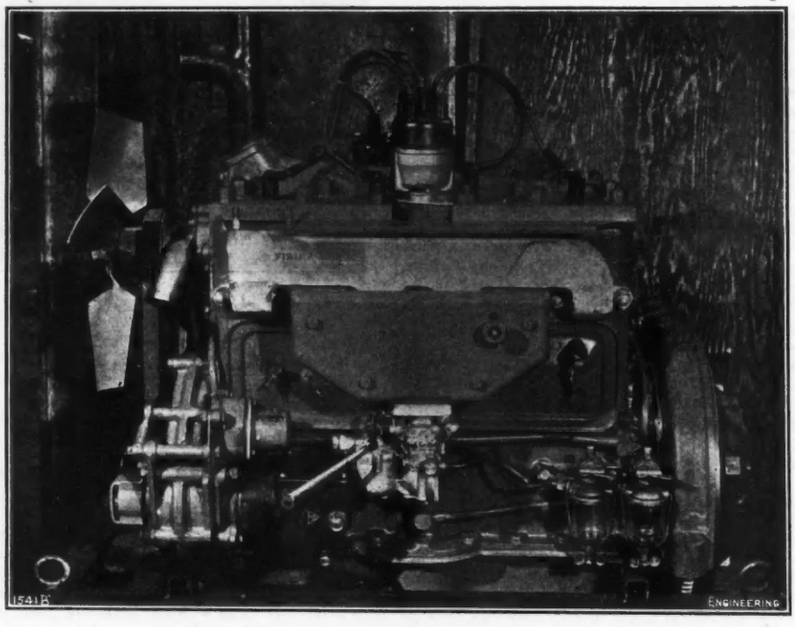


FIG. 2. VAPORISING-OIL ENGINE FOR M4 TRACTOR; NUFFIELD ORGANISATION.

TRACTOR WITH VAPORISING-OIL ENGINE.

The tractor, however, forms the very backbone of modern mechanised agriculture, for this machine is being used for an ever-increasing number of duties which range from normal cultivation work to such diverse uses as hedge cutting and driving and hauling combine harvesters, baling machines, etc. To meet these demands, the tractor manufacturers are constantly endeavouring to improve their machines so that they will withstand the arduous duties placed on them. At this year's Show, for example, the Nuffield Organisation, Cowley, Oxford, will be showing an improved version of their Universal tractor fitted with a new vaporising-oil engine, a new overload release mechanism and a modified hydraulic power unit designed to give an

ROYAL AGRICULTURAL SHOW, BLACKPOOL.

FIG. 3. TRACTOR-MOUNTED DISC TERRACER; HARRY FERGUSON, LTD.

FIG. 4. REVERSIBLE HEAVY-DUTY DISC HARROW; HARRY FERGUSON, LTD.

improved method of power selection. A tractor fitted with the new vaporising-oil engine is shown in Fig. 1, opposite, and the engine is shown separately in Fig. 2. The new power unit gives 10 per cent. greater power than its predecessor, the horse-power measured at the flywheel being 35 at 1,400 r.p.m. and 43 at 2,000 r.p.m.

In general, the design of the new engine follows conventional lines, the increased output having been obtained by attention to details such as the redesigning of the combustion chambers, camshaft and pistons. Engine life has been increased by lowering the compression ratio and improvements have been made to the cooling system and its associated water pump and the oil and air filtration systems. There are four cylinders with a bore and stroke of 100 mm. and 120 mm., respectively, the capacity thus being 3,770 c.c. The cylinder head is detachable and both the crankshaft and camshaft are supported by three bearings. Light-alloy pistons are employed and each is fitted with two pressure rings, one scraper ring and one oil-control ring. A centrifugal governor is fitted as standard and this operates at any speed between the limits of 600 r.p.m. and 2,000 r.p.m., hunting being eliminated by the use of a hydraulic damper or dashpot. A Solex bi-fuel carburettor is used thus permitting instantaneous starting on petrol at any time without the necessity of draining the float chamber. Cooling, as previously indicated, is on the thermo-syphon system assisted by a centrifugal pump, the operating temperature being thermostatically controlled. Separate filters are provided for the vaporising-oil and petrol systems and ignition is by a coil and distributor working in conjunction with a 12-volt battery.

To reduce the tendency for the front end to lift when working over difficult ground, the latest version of the Universal tractor is fitted with a drawbar designed so that the pull is transferred to the underside of the tractor. The overload mechanism previously mentioned is designed to operate in conjunction with this drawbar and consists of a spring-loaded anchorage for the drawbar frame which is adjusted to withstand the normal resistance of the implement at work. Any increase in this resistance, such as may be caused by the implement striking a rock or other hidden obstacle, trips the spring-loaded anchorage and the tractor is stopped immediately. The tripping load can be adjusted by means of a handscrew situated within easy reach of the driver and the design of the mechanism is such that it operates with both trailed and mounted implements.

TRACTOR-MOUNTED DISC TERRACER.

One of the outstanding advances made during recent times in mechanised farming has been the development of mounted implements whereby the implements are attached to the tractor to form an integral unit. This system was pioneered by Mr. Harry Ferguson, and at this year's show Harry Ferguson, Limited, Coventry, will be showing six new implements designed to operate in conjunction with the Ferguson tractor. One of these, namely, a disc terracer, is illustrated in Fig. 3, on this page. The design of this implement is based largely on that produced by Harry Ferguson, Inc., of Detroit, U.S.A., which has already been used with outstanding success in the formation of contour ridges for soil-conservation purposes. The English form is almost identical with that produced in America and will be marketed in those countries which have been precluded from buying the American type owing to dollar shortages. As will be seen from the illustration, it is a tractor-mounted implement and consists basically of a single large disc set between the right-hand, or offside, front and rear wheels. Its main function is the construction of terraces, irrigation furrows, ditches, water channels and contour bunds or ridges. It can, however, be employed as a single-disc plough, as shown in the illustration.

As in most Ferguson implements, the terracer, when attached, becomes an integral part of the tractor, thus giving accuracy of control combined with tractor stability; furthermore, the need for supporting framework is reduced to a minimum. Although the disc is not rear mounted, the implement has been designed to take full advantage of the tractor's hydraulic control system, raising, lowering and adjustment of the working depth being effected hydraulically. The suction produced by the action of the disc in the soil is transmitted to the tractor so as to give additional adhesive weight in much the same way as for the Ferguson mounted plough. The disc is 28 in. in diameter and is mounted on roller bearings. The maximum operating depth is 14 in. and a 12-deg. disc-angle adjustment is provided. Fitting of the implement to the tractor is a simple operation as the parts have been made as light as possible consistent with strength.

REVERSIBLE HEAVY-DUTY DISC HARROW.

Another new implement to be shown at the Royal for the first time by Harry Ferguson, Limited, is illustrated in Fig. 4, on this page, and is known as the reversible heavy-duty disc harrow. The implement has been designed for use in rough ground and should prove particularly suitable for opening up undeveloped land. It consists of a square transverse beam to which is connected two bearing bracket assemblies, each of which, in turn, supports one gang of discs. The gangs are free to swing through 180 deg., and, according to their position, are able to throw the soil either towards or away from the centre of the implement. The harrow is supported from the rear three-point linkage of the tractor, thus enabling it to be brought into, and out of, use by means of the hydraulic system. The implement can be used for a variety of purposes, such as the breaking down of furrows and clods, and the preparation of virgin land; normal harrowing duties in citrus-fruit orchards, etc.; soil conservation work; and in exceptionally wet areas where it is the practice to make "beds" on which to plant the crop. Conversely, it can be used in dry areas to form furrows in which water can be retained. Three models of the harrow will be available, the main difference between them being working width and size of disc. All models will be fitted with the cut-away type of disc shown in the illustration, as these have been found to work more efficiently in heavy trash and give better penetration in hard soils. The cutting angle of the discs is adjusted by a single lever within easy reach of the tractor driver and the tilt of the disc gangs is regulated by means of thrust links designed to give six alternative degrees of tilt. A weight box situated forward of the link pins is used to keep the centre of gravity as close as possible to the tractor.

(*To be continued.*)

BRITISH BROADCASTING DEVELOPMENTS.

AN account of the plans made for developing the television service in this country was given by Sir Ian Jacob, Director-General of the British Broadcasting Corporation, at a Press conference on Tuesday, June 23. The present position, he said, was that five high-power stations were in operation. Plans had also been made for the erection of the same number of medium-power stations, but the Government had only authorised the erection of two of these on a temporary basis. The Lime Grove studios at Shepherds Bush had been extended and three regional units were in use. On an average a television service was available for five hours a day, although this might be increased when there were important outdoor events.

The first step was to complete the five medium-power stations. When this had been done 90 per cent. of the population would be within effective reach of the television service. The next step would be to complete the national coverage by increasing the power of the London station and to erect a further eight low-power stations in the Channel Islands, the Isle of Man, East Anglia, South-West England, West Wales, Cumberland, Inverness and Londonderry. When this was done the complete chain of 18 stations would cover well over 95 per cent. of the population of Great Britain and Northern Ireland. Concurrently, the service would be extended by a further two hours a day and a news service in vision would be introduced. The solution of two further problems would then be necessary: the provision of an alternative service and the development of means whereby more programmes could be produced in the regions. This would require the provision of a second chain of stations which, if the frequencies were made available (as was by no means certain), would be developed by building high-power stations to cover the main centres of population followed later by low-power stations to fill the gaps. This would provide an alternative service of five hours a day.

Speaking of colour television Sir Ian said that it might be possible to introduce this at some time during the ten-year period. It was essential, however, that transmissions in colour should be receivable in black and white on existing sets. Moreover, it was too early to say whether a thoroughly satisfactory service could be evolved. In any event the majority of programmes were likely to remain in black and white.

As regards the future of the sound services, statistics reinforced the evidence from other sources that this form of broadcasting would remain of the greatest importance and that measures must be taken to overcome the difficulties in reception caused by shortage of medium wavelengths and interference from Continental stations. There was no way of dealing with the latter difficulty except by the use of very high frequencies and, if the Corporation's view were supported by the Television Advisory Committee, these would be introduced at an early date. They had planned to erect stations which would gradually fill up the present weak areas of reception and act as a reinforcement rather than a replacement of the long-wave and medium-wave networks. These technical developments would be accompanied by a progressive development of the standard of the programmes.

Sir Ian emphasised that to complete this programme the capital expenditure over the next ten years would amount to three million pounds per annum or 50 per cent. greater than the level to which the Corporation was now restricted and that the revenue expenditure in the same period might on the average be 60 per cent. more than in 1951-52. The increase in revenue, due to the growth of television licences, would not be sufficient to finance the whole plan and it was not possible to say what steps would be taken by the Government to provide the money required. At present the Corporation received about 15*s.* 9*d.* from each sound licence and 31*s.* 6*d.* from each combined sound and television licence. It was calculated that if prices did not rise too rapidly the whole programme could be carried through without raising these amounts beyond 1*l.* and 3*l.*, respectively.

LABOUR NOTES.

A LEGALISED minimum wage for all classes of workpeople in Britain was proposed by Mr. Robert Edwards, the general secretary of the Chemical Workers' Union, at the opening session of the union's annual conference at Wortley, near Sheffield, on June 27. Mr. Edwards said that such action might well be taken as a first step towards the establishment of a national wages board, the functions of which would be to decide what the nation could afford to pay out in wages and salaries. The national minimum wage should be linked to a revised retail cost-of-living index. In the view of the union's executive, that would be the best method under the existing conditions, of ending the present deplorable practice of wages always chasing prices.

The very fact that there was a policy of wage restraint, Mr. Edwards suggested, proved that the basic principle of collective bargaining no longer operated effectively. Trade unions might gain a complete victory for their wage demands, by using their collective-bargaining power, but their gains would be discounted by the inflation which would result, and no amount of governmental control could halt this. As things were, there was a wage scramble, with wages tending to become stabilised at the level for unskilled work, and many industries were paying the lowest rates possible, based on the working of the least efficient firms.

All this militated against obtaining the increased productivity on which the country's future depended. Any wage scheme, to be realistic, had to meet two essential requirements: the needs of the national economy and the requirements of social justice. The obvious solution to the problem was acceptance of the principle of a national wage policy. Later, the delegates passed a resolution urging the Trades Union Congress to agree to the adoption of a legalised minimum national wage based on a new cost-of-living index.

Referring, subsequently, to the future of the chemical industry in Great Britain, Mr. Edwards described the plans of the Labour Party as being "far from clear," and said that they did not give details of the structure of the companies the Party proposed should be acquired. It was the opinion of the union that the public ownership of chemical-production enterprises would not solve the problems that had arisen from the nationalisation of other industries, unless such ownership was based on democratic principles, giving control of the industry to all parties concerned, technicians, workpeople, and consumers.

The union had condemned the structure of the industries already nationalised and had offered detailed proposals for their democratisation. It did not advocate the control of chemical production for the sake of planning, because planning without industrial democracy was not socialism. The private ownership of the chemical industry, Mr. Edwards continued, was wasteful and inefficient, and it was wrong for great power over the lives of others to rest in the hands of a few business men. Nationalisation, however, would not solve the problem if it concentrated greater power into fewer hands.

Anxiety lest lower-paid employees should not obtain their due share, in the scramble after higher wages, is one of the more noticeable features of the list of motions which are to come before the delegate conference of the Transport and General Workers' Union at Southsea later this month. Altogether, the agenda, issued last Monday, contains approximately 480 motions and these may be taken as representative of rank-and-file opinion in the trade-union movement generally. The immediate aim of the workpeople, judging from these motions, appears to be to secure increased industrial democracy, and a greater equality in working conditions, sick-pay, and pensions, between manual employees and those engaged in technical and office occupations. The nationalised industries seem to them to offer the greatest scope for a commencement to be made in the attainment of these objects.

One motion advocates boldly that, in future, workpeople in a nationalised industry should have full participation in management. Another affirms that there is insufficient scope in the nationalised industries for the ideas and initiative of the staff of any grade. Many branches express strongly the view that the policy of the Government with respect to food subsidies has greatly added to the cost of living. There is a widespread demand for efforts to reduce living costs and much suspicion of the official index of retail prices. It is suggested that the union should compile an index of its own.

Several motions are critical of those unions, including the T.G.W.U., which have co-operated, in any way, with the present Government. A few branches object to the opinions expressed by Mr. Arthur Deakin, the general secretary, on the relation of trade unions with whatever Government happens to be in power, irrespective of its politics. The motion of one branch suggests that there might have been less unofficial action in the campaign against the denationalisation of road transport if the union had called a national delegate conference to discuss the matter. By way of relief, there are the usual optimistic suggestions that firms should pay for travelling time and that payments for overtime should be exempted from taxation.

Mr. Osbert Peake, the Minister of National Insurance, has requested his National Insurance Advisory Committee to consider whether the rules governing the payment of national insurance benefit during very short spells of unemployment or sickness are the most satisfactory, especially in cases where an applicant is also in receipt of payments from his employer, and, if thought appropriate, to make recommendations, provided that these do not increase the liability of the national insurance funds.

Two non-union electricians in the employ of the London County Council were discharged by the Council, on June 24, in order to avoid a threatened strike by members of the Electrical Trades Union. The men concerned are stated to have declined to take part in an unofficial strike in 1951, and were later excluded and fined by their union, the E.T.U. The circumstances which led to the men's refusal to take part in an unofficial strike being followed by their expulsion from the union are not apparent, but it seems that the terms of their re-admission were not acceptable to them and they also came into conflict with the union regarding the payment of their fines and subscriptions.

A statement issued by Mr. I. J. Hayward, leader of the Council, with reference to the Council's action, explains that the E.T.U. insisted that the men should rejoin and that the men "failed to co-operate" during efforts by the Council to mediate in the dispute between them and the union. Eventually, some 350 members of the union employed by the Council had threatened to strike because of the employment of two non-unionists. The situation, the statement continues, did not arise from any application of the closed-shop principle, but as a result of the failure of two former trade-union members to abide by union rules and to retain their membership. Although the Council was not committed to a closed-shop policy, it encouraged all its staff to be members of the appropriate union. A strike would have caused serious dislocation of public services.

On its side, the union had expressed its willingness to give sympathetic consideration to an application from the men to rejoin, and had given assurances that, within the union's rules, every facility would be given for a fair hearing of the application. Since the men would not settle their differences with the union in accordance with the rules, the statement concludes, the only course left open to the Council was accordingly to terminate their employment.

HEAVY-DUTY MILLING MACHINE.

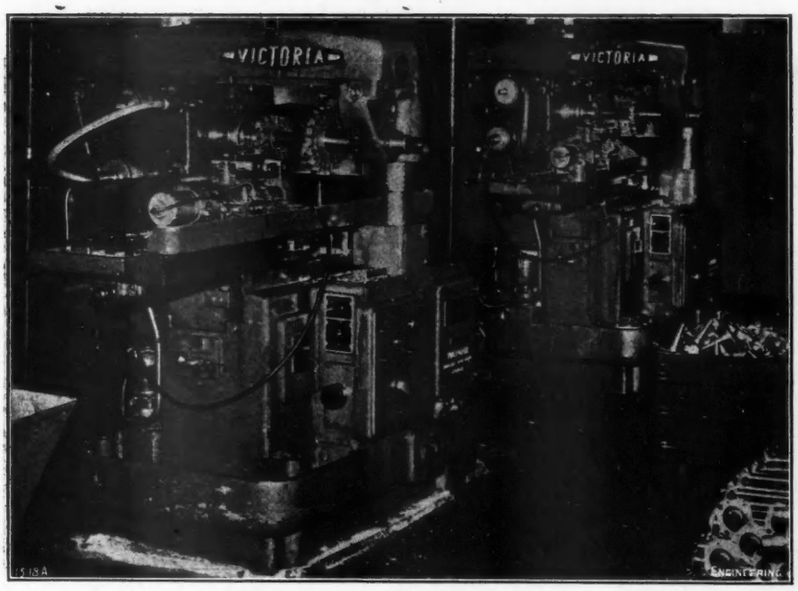


FIG. 1. MILLING MOTOR-CAR STUB-AXLES.

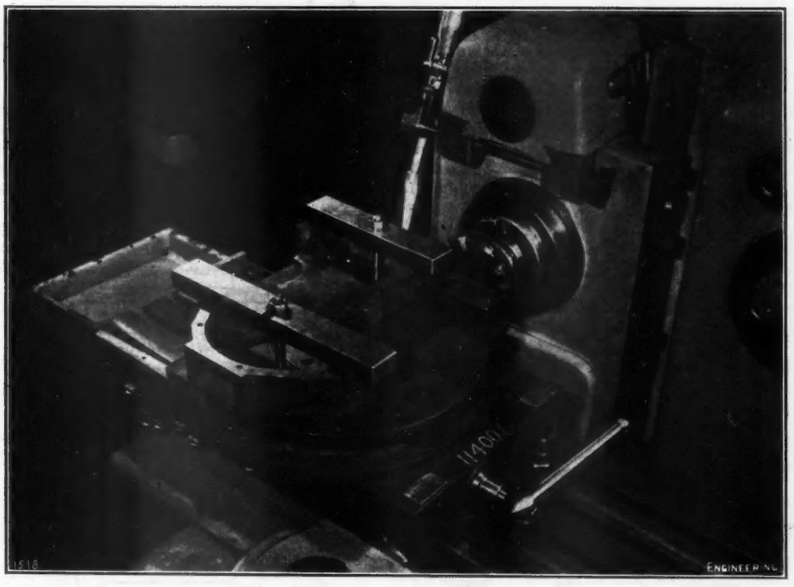


FIG. 2. INDEXING FIXTURE.

HEAVY-DUTY MILLING MACHINE.

THE milling machine illustrated in Figs. 1 and 2, herewith, is a product of the Victoria Machine Tool Company, Limited, Victoria Works, Willesden, London, N.W.10, and is a development of an earlier and smaller type. The previous model had a table traverse of 26 in., but in the new machine, to which the name "Victomatic" has been given, the traverse has been increased to 30 in. Fig. 1 shows two of the new machines in the works of the Austin Motor Company, Limited, employed in gang-milling the bosses on stub axles for the A30 Austin car, and Fig. 2 illustrates an indexing fixture on a machine in the works of Messrs. F. Perkins, Limited, Peterborough. In this instance, it was necessary to hold two faces of the workpiece (a timing case) to within $\pm 0{\cdot}001$ in. from locating dowel holes. The machine is set for an automatic cycle so that the table is rapidly returned after face-milling each side. The operator then indexes the fixture to the next station and re-engages the table feed. The faces are milled with a feed of 11 in. a minute, giving a cycle time of about 3 minutes.

The bed of the Victomatic milling machine is a one-piece casting, well ribbed to ensure rigidity, and the column carrying the headstock is bolted and dowelled to it. The drive is by an 8-h.p. built-in electric motor, in which the stator is formed in the headstock casting, and is transmitted to the milling spindle through pick-off change gears and a final single-helical gear to the splined spindle extension. The spindle nose has a No. 50 standard taper. All the headstock gears are ground, and the shafts are carried in either ball or roller bearings. Twenty speeds are available, ranging from 30 to 1,100 revolutions per minute. Lubrication of the spindles and gearing is automatic, the oil being circulated by a built-in pump. The milling spindle is supported in preloaded taper-roller bearings, mounted in a quill. Axial adjustment is by rack and pinion through a reduction gear.

The over-arm which carries the outer bearing of the milling spindle is of particularly rigid construction and can be secured firmly to the machine base by the tubular column which can be seen in Fig. 1; the effect is then to provide a completely closed frame to support the spindle and cutter. When face-milling is to be done, the column can be retracted into the machine bed. An ammeter gives a check on the power consumption, thus indicating when the cutters need sharpening.

The table is driven by a lead-screw and adjustable nut through a feed gearbox mounted on the end of the bed. By the use of differential gearing, running in an oil-bath, for both the feed and the quick traverses, it has been possible to dispense with clutches. The quick traverses can be engaged with a smooth acceleration which minimises torsional deflection of the shafts. A back-gear in the feed drive extends the range of feeds through the pick-off gears, thus providing a convenient means of increasing the feed rate during operation. The feed motion is driven by a motor of $1\frac{1}{2}$ h.p. and the rapid traverse by a $1\frac{1}{2}$-h.p. stator-rotor unit, of similar type to the spindle motor, housed in the feed-box casting. The 24 feeds range from 1 in. to 40 in. a minute, and the quick traverse is at 112 in. a minute. A brake, operated by a solenoid, is provided to stop the rapid-traverse motor when the feed is engaged. A selector lever, among the conveniently-grouped controls, switches the machine from manual to automatic operation. When manual operation is engaged, however, the table still responds to either of the rapid-traverse control buttons, and both spindle and table stop instantly when the button is released.

Various automatic cycles can be set up, including pendulum milling and skip feeding. The process is simple, as the trip dogs operate separate switches, which are suitably protected against the ingress of coolant and swarf. Automatic sequences are started by depressing the rapid-traverse button to bring the work up to the cutter. The first feed-trip dog to engage with its switch cuts out the rapid traverse, whether the button is still depressed or not. The switchgear is mounted on the machine column and all contactors, etc., are readily accessible by removing a single cover. The several motors are protected by self-resetting overload trips, and the entire circuit by a no-volt release contactor. A warning light indicates when the primary circuit is energised and another lamp shows when the machine is completely stopped. The spindle direction can be changed by means of a reversing switch, and a three-position selector switch enables the spindle to be run during the feed and rapid-traverse, and during feed only, or to be held stationary irrespective of the table movement.

For pendulum milling, the machine must be equipped for climb milling, for which purpose a device to prevent backlash is incorporated in the table drive. The table is advanced by a light friction drive which operates at a faster rate than the main traverse screw and nut, so that the friction drive is forced to slip. This ensures that the table is advanced fully before the cutter engages the workpiece, thus preventing any "snatch" in cutting. The device is cut out automatically during rapid traversing, and by a switch when the machine is employed for ordinary milling.

The base of the machine, which is in one piece with the body, forms a tank to hold the supply of coolant, and is surrounded by a deep trough to catch chips and to prevent leakage of the coolant on to the floor. The coolant pump runs submerged, and so does not need priming. The equipment includes a cabinet to contain the spindle and feed-drive change gears, additional trip dogs, etc. The machine is marketed by the Rockwell Machine Tool Company, Limited, Welsh Harp, Edgware-road, London, N.W.2, who are the makers' sole agents for its distribution in the United Kingdom.

FROZEN-STRESS PHENOMENON IN PHOTO-ELASTICITY.—The Institution of Mechanical Engineers is to publish a paper, of which advance copies are available, entitled "'Frozen Stress' Phenomenon in Photo-Elasticity," by H. Fessler, B.Sc.(Eng.), A.M.I.Mech.E. After a brief historical résumé of earlier work, the paper reports a series of tests carried out at differing temperatures and under various stresses on three materials, "Marco Resin SB. 26c," "Fosterite" and "Bakelite." Communications are invited and should reach the Institution by August 15, 1953.

HIGH-PRESSURE PUMP FOR AUTOMATIC OUTPUT REGULATION.

THE Howard Proportionometer pump is manufactured by the Howard Pneumatic Engineering Company, Limited, Eastbourne, Sussex, under Moore and Charlton patents, and is now obtainable with an automatic servo-operated regulating device which can be coupled to an instrument such as a temperature, pressure or flow controller to regulate its output in accordance with a particular need. Various models are designed to deal with up to 2,000 gallons an hour at pressures of up to 12,000 lb. per square inch. Fig. 1 illustrates a double-ended version designed to deal with two distinct liquids, the ratio between which may be varied, at will, between 1 : 1 and 1 : 0, while the total throughput of the pump is automatically varied to suit volumetric demand by varying the speed of the pump, variation in the pump speed being obtained by a Carter variable-speed unit controlled by the automatic device, which is shown mounted on the Carter unit with its cover plate removed. A number of sets of this type are now operating in recently-built oil refineries in the south of England.

The principle of the pump may be explained by reference to Fig. 2, which shows one plunger at the end of its inward stroke and one at the end of its outward stroke. With the plungers so set, and working in opposite directions, the liquid in the valve chambers merely swills and there is no discharge. Provision is made, however, for varying the relative positions of the plungers, from the position shown in the figure, to the position where they are completely in phase and stroking exactly together, when, of course, the maximum discharge of the pump through the valve chamber is obtained. The manner in which a variation in the phasing is obtained is ingenious, and is based on a differential mechanism. A worm-wheel, which rotates freely on the shaft and is shown in Fig. 2 driven by a vertical-spindle worm and motor, is directly bolted to an eccentric, which reciprocates the left-hand plunger through a slipper and yoke mechanism. Bolted in turn to the eccentric is the first bevel-wheel, which meshes with a bevel-pinion mounted in a housing that is fixed to the shaft and is, therefore, rotatable on rotating the shaft; this bevel-pinion meshes with a second bevel-wheel, in turn bolted to a second eccentric which reciprocates the right-hand plunger by means of a second slipper and yoke mechanism. It will be clear that with the bevel-pinion axis fixed, the second eccentric must rotate at the same speed as the first, but in an opposite direction, and that if this bevel-pinion axis is moved round by rotating the shaft through a few degrees, the phasing of the second bevel-pinion and eccentric relative to the first is advanced or retarded as the case may be, with the result that the two plungers may be made to operate in any desired position between being exactly in phase and exactly out of phase. Thus the throughput can be varied from the designed maximum to zero.

The main shaft is rotated either by a worm and hand-wheel, or by a double-piston controlled crank, as shown in Fig. 2, which is part of the automatic servo-operated regulating device. The type of pump illustrated in Fig. 1, however, has one set of plungers at one end, each with its own cylinder and valves, and, therefore, irrespective of the phasing between the two plungers, the output per revolution remains constant; at the other end of the machine the two plungers have a common valve chamber, and, therefore, phasing of the plungers varies the output per revolution and, thereby, the ratio between the volumes of the two liquids pumped.

The working of the automatic regulating unit shown in Fig. 2, to control the position of the main-shaft with its bevel-pinion housing, is explained by reference to Figs. 3, 4 and 5. Fig. 3 shows the relative positions of the pilot valve, sleeve valve, feed-back cam and link, and the operating pistons, for some particular output, and it will be observed that the pilot valve blocks the ports in the sleeve valve, so cutting off the oil supply from the pressure pump to the operating pistons and

AUTOMATICALLY-CONTROLLED PUMP.

HOWARD PNEUMATIC ENGINEERING CO., LTD., EASTBOURNE.

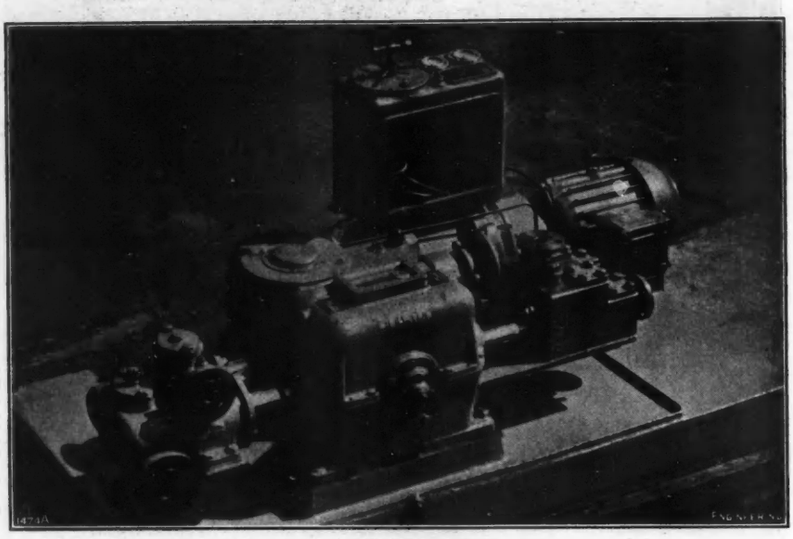


FIG. 1. BI-LIQUID PUMP.

Fig. 2. SINGLE-ENDED PUMP WITH AUTOMATIC SERVO-OPERATED REGULATING DEVICE.

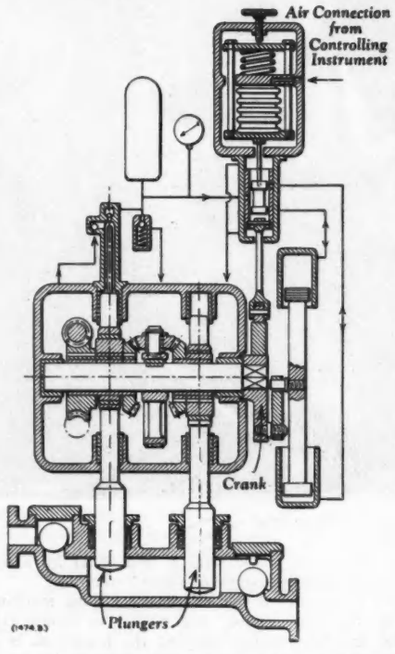


Fig. 3. VALVE POSITIONS WHEN STEADILY PUMPING.

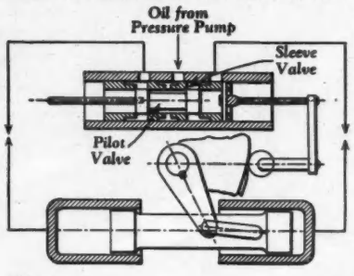


Fig. 4. VALVE POSITIONS WHEN CHANGE OF OUTPUT IS DEMANDED.

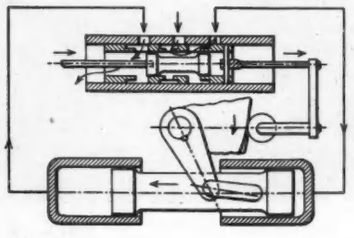
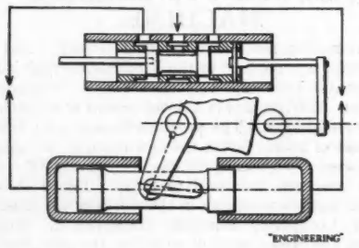


Fig. 5. VALVE POSITIONS AFTER CHANGE IS MET.



cylinders. In Fig. 4, the pilot valve is shown as having been moved to the right by air pressure admitted by the controlling instrument, acting through the bellows and calling for a change in the output of the pump; immediately, oil flows into the right-hand operating cylinder via the now uncovered port in the sleeve valve, while oil in the left-hand operating cylinder escapes back to the oil-pump sump via the other sleeve-valve port. This causes the piston to move from right to left and the crank to rotate (through a few degrees) the shaft to which the housing carrying the differential bevel-pinion is attached, so changing the phasing of the plungers, and, therefore, the output; but, in moving, the feed-back cam (which is rigid with the crank) brings the sleeve valve also to the right, when its ports are then closed by the piston in its new position. The oil supply is then cut off and the mechanism reaches its new position of equlibrium as shown in Fig. 5.

The controlling instrument which admits compressed air to the bellows to move the pilot valve can take many forms, depending on whether it is desired to maintain a constant pressure and to vary the output of the pump, or to maintain in a vessel,

HOT-METAL RECEIVERS FOR IRON FOUNDRIES.

MONOMETER MANUFACTURING CO., LTD., LONDON.

Fig. 1.

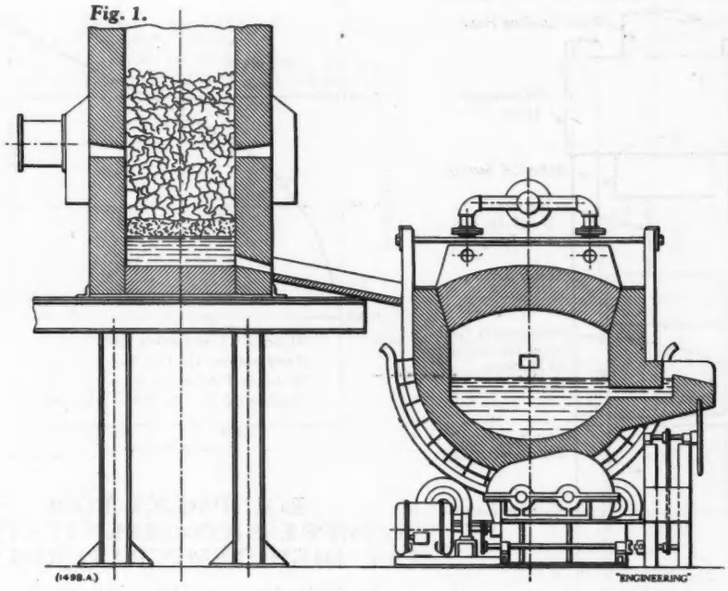


FIG. 2. MOBILE RECEIVER.

a constant temperature by varying the input, or to inject chemicals in quantities governed by a logarithmic curve or by time cycles, as is required for some biological processes.

Apart from the many obvious uses for such an instrument-controlled pump—particularly in oil refineries, where many are already at work—the possibility of using the pumps for boiler feed is one which seems well worth exploring, since a pump which can be made to follow and react instantaneously to steam demands appears to make possible a true flash boiler, producing steam of uniform pressure and temperature, irrespective of the steam demand. Its suitability for use with orthodox boilers is clearly apparent.

ELECTRICITY SUPPLY STATISTICS.—During May, 1953, 4,404 million kWh were sold by the British Electricity Authority to the Area Boards, an increase of 5·4 per cent. over the output in the same month of last year. When corrected for the weather and the number of working days, the increase was, however, 7 per cent., the weather having been slightly colder and the number of effective working days less than in May, 1952. The amount of electricity sent out by the Area Boards during the same month was also 4,404 million kWh (some supplies are obtained from sources other than the Central Authority), compared with 4,180 million kWh in May, 1952, an increase of 5·4 per cent. Supplies to "mainly industrial" areas increased by 2·6 per cent. and to "mainly non-industrial" areas by 9·7 per cent.

INTERNATIONAL FEDERATION OF PRESTRESSING.—Arrangements are being made for the first general assembly of the International Federation of Prestressing to be held at the Institution of Civil Engineers, Great George-street, London, S.W.1, from Tuesday, October 6, to Friday, October 9. The chairman of the Prestressed Concrete Development Group of the Cement and Concrete Association, Mr. D. H. New, will welcome the delegates and preside during the election of the governing body of the Federation. Three technical sessions will take place during the meeting; one on the afternoon of October 6, and one each on the mornings of October 7 and 8. Papers to be presented at these sessions will be, respectively, "The Influence of Abnormal Temperatures on Prestressed-Concrete Constructions," "Design of Statically-Determinate Beams and Slabs in Prestressed Concrete, Based on Ultimate Load" and "Statically-Indeterminate Structures in Prestressed Concrete in the Elastic and Plastic Phases." The afternoons of October 7 and 8, and the whole of October 9, will be devoted to visits and excursions. Programmes and further information may be obtained from the secretary of the Prestressed Concrete Development Group, 52, Grosvenor-gardens, London, S.W.1.

HOT-METAL RECEIVERS FOR IRON FOUNDRIES.

ALTHOUGH the foundry cupola provides an economical method of melting iron, its output is intermittent, and it suffers from the drawback that it has no considerable storage capacity for hot metal. Both these points are of considerable importance in a modern foundry, especially in motor-car and similar plants where moulds operating on the conveyor system have to be poured. In order to improve the performance of the normal cupola, increasing use is being made of hot-metal receivers, either oil- or gas-fired. That shown in Fig. 1, on this page, is one of a battery of oil-fired receivers, each of 5 tons capacity, installed by the Monometer Manufacturing Company, Limited, Savoy House, London, W.C.2, in a mechanised foundry in the south of England. The receiver, besides providing at all times an adequate reserve of metal, ensures that this is always at the precise temperature required, usually from 1,440 deg. to 1,500 deg. C. When a hot-metal receiver is adopted, a normal cupola becomes a far more flexible instrument of production.

In operation, the usual method is for the receiver to be heated up at the commencement of the day's work to a temperature about 50 deg. C. above that of the metal tapped, and the design is such that the cupola metal can be teemed into one side of the receiver while, by means of its tilting mechanism, this is also pouring. Thus, a constant through-pour of hot metal is ensured which obviates any hold-up in production. The main constructional features of the hot-metal receiver may be gathered from Fig. 1. The oil-burner fires into one end of the furnace chamber, and the operation is regenerative in that the exhaust gases from the chamber are used to preheat the air supply, furnished by a motor-driven fan, by passing the air through a regenerator in the furnace arch. The oil-fuel burner used operates under an air supply at a pressure of 2 lb. per square inch. The particular receiver installation illustrated is entirely self-contained and fully mechanised, under push-button control, but the reduction gearing for the tilting mechanism embodies a clutch which enables a handwheel to be brought into operation for this purpose in the event of current failure. Silica bricks are employed both for the arch and the side feathers of the receiver, and the life of a lining in regular operation in an average foundry is from six to nine months. The design is such as to permit of a complete re-lining with bricks during a week-end shut-down period.

The average hourly consumption of the 5-ton receiver illustrated in Fig. 1 is 12 gallons of oil per hour when passing metal through at the rate of 10 tons per hour. While the illustration shows a hot-metal receiver installed in connection with a single cupola, the arrangement is very flexible and can be made to suit the requirements of individual foundries. For instance, a single receiver of the stationary type may be fed by a number of cupolas by means of suitable launders which take the metal to the receiver. Alternatively, the receiver itself may be mobile by being mounted on a four-wheeled bogie, as shown in Fig. 2, in which case the receiver is afforded the necessary radius of action by flexible piping to the burners. This permits of a maximum travel of up to about 4 yards. In other cases, the receiver may be wheeled to a second cupola and re-coupled to the fuel-supply and air-supply lines.

NEW BROADCAST TRANSMITTING STATION IN WALES.—The British Broadcasting Corporation state that the new Welsh Home Service transmitting station at Towyn began operating on Sunday, June 21, when it replaced the temporary transmitter which has been at work on the same site since December, 1952. It has an output of 5 kW and is therefore the largest of the low-power stations which have been brought into operation in various parts of the country during the past two years. It is designed to work on a wave length of 341 m. and to be remote controlled. In addition to the main 5-kW transmitter, there is a 2-kW stand-by transmitter, both of which were manufactured by Marconi's Wireless Telegraph Co. Ltd, Chelmsford. The new station will extend the local coverage, though the area of improved reception will not reach far inland owing to the barrier formed by the mountains.

CONVERSION OF "STRATHAIRD" AND "STRATHNAVER" TO ONE-CLASS LINERS.—In anticipation of the delivery next year of the 28,000-ton liners Arcadia and Iberia, for use on the service to Australia, the Peninsular and Oriental Steam Navigation Co. have decided to convert the Strathaird and the Strathnaver to carry tourist-class passengers only. Since the war, these vessels have each carried some 570 first-class and 470 tourist-class passengers on voyages to India, Ceylon and Australia. After conversion to one class, their passenger-carrying capacity will be increased to 1,200 each. The decision is in accordance with the company's normal practice of transferring older vessels to an intermediate status when new tonnage becomes available. It is expected that the Strathaird will be making her first voyage as a one-class vessel from London on April 8, 1954, and the Strathnaver on July 29, 1954.

COMPRESSION-CREEP TEST MACHINE.

Fig. 1.

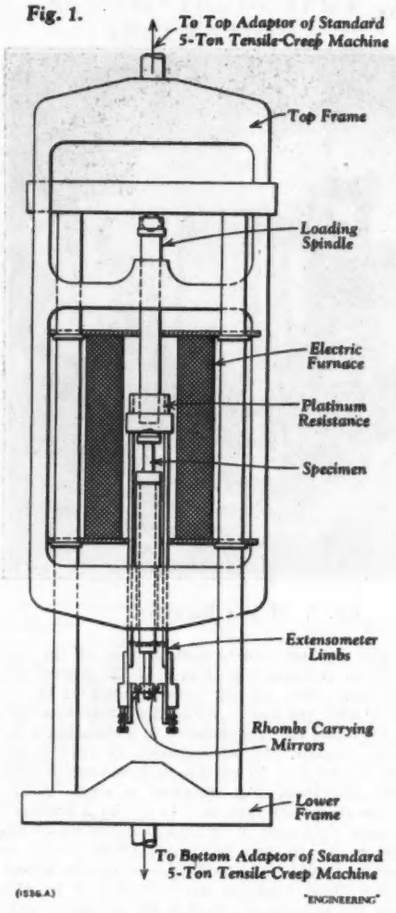


Fig. 2. SPECIMEN SEATINGS AND EXTENSOMETER LIMBS.

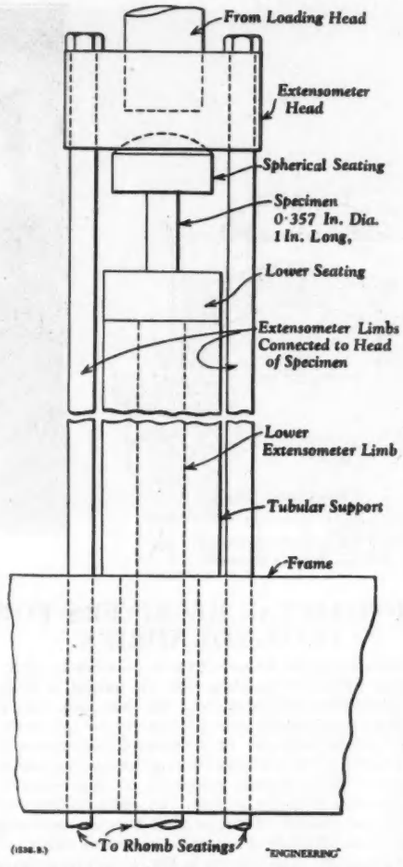
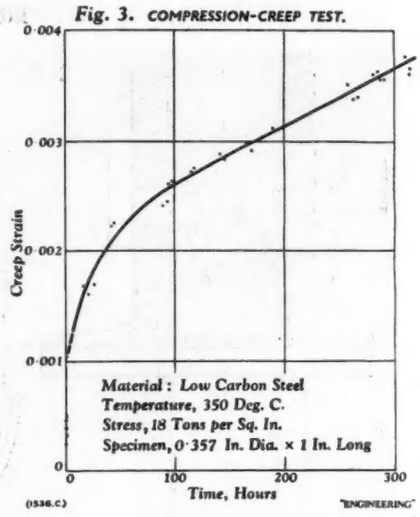


Fig. 3. COMPRESSION-CREEP TEST.



BACK-PRESSURE STEAM PLANT AND FUEL ECONOMY.

IN reply to a question in the House of Commons on Monday, June 22, the Minister of Fuel and Power (Mr. Geoffrey Lloyd) said that as very valuable fuel savings could be made by passing steam through engines or turbines before using it for heating purposes, he had decided to make a survey of the potentialities of generating power in this way. This survey is to take the form of a questionnaire, which was circulated last week to about 3,000 industrial undertakings, each consuming over 2,000 tons of coal per annum, and also to certain non-industrial establishments, such as hospitals and schools. Information is requested on the solid and liquid fuel and gas consumption during the latest convenient year by stationary steam boilers, hot-water boilers and for other purposes. The total electricity obtained from outside sources during the year and the maximum demand are also to be stated.

Further data is asked for on the plant installed, including, in the case of engines or turbines, the type of exhaust, the maximum continuous rating, the age, and the total production of electrical or mechanical energy; and, in the case of boilers, the type, number, normal rate of steam production, maximum permissible working pressure and age. Participants are also asked to give their total annual steam production and the pressure, quantities and purposes, e.g., engines, space-heating or processes for which it is employed, as well as the number of hours during which it is used during an average summer and winter week. The nature of the process steam load, i.e., whether it is fairly steady or fluctuating, is also to be stated; and, if the latter, whether hot-water storage, steam accumulators or other devices are used to eliminate peak demands. Finally, it is asked if the idea of installing back-pressure turbines or engines (or extending their existing capacity) has been considered and, if so, what were the difficulties which prevented the project being proceeded with. It is requested that replies to the questionnaire should be sent in within a month and it is hoped that provisional summary results (which will not reveal details of individual firms) will be available early in the New Year. It is estimated that the fuel consumption of the undertakings involved in this survey is about 30 million tons per annum, so that the scope of the inquiry is satisfactorily wide. Caution will, however, be necessary in drawing general conclusions from the results, owing to the widely different operating conditions in individual industries and factories. Nevertheless, the data provided should be of assistance in throwing light on a matter which has hitherto been a little obscure. It may even show that the idea that present difficulties can be overcome by the widespread installation of this class of plant is an over-simplification of the problem.

THE LATE MR. G. E. WELLS.—We note with regret the death of Mr. George Ernest Wells, which occurred on May 23 at Beccles Hospital, Suffolk. For many years an employee and a director of Edgar Allen & Co. Ltd., Imperial Steel Works, Sheffield, 9, he had latterly served on the staff of K. and L. Steelfounders and Engineers, Ltd. Mr. Wells's education was completed in France and he joined Edgar Allen & Co., where his father, the late Mr. A. E. Wells, was a managing director, in 1899. He was appointed assistant foundry manager in 1906, and played a considerable part in the design and equipment of a new steel-foundry plant erected at Imperial Steel Works in 1912. In 1917, he was granted permission by the board to take up the temporary position of deputy director of steel castings under the Ministry of Munitions, and continued in that capacity until the end of hostilities. On November 26, 1918, Mr. Wells was elected a director of the company. In 1936, he relinquished this position and took up an appointment with Kryn and Lahy (1928), Ltd., Letchworth, now K. and L. Steelfounders and Engineers, Ltd.

EQUIPMENT FOR COMPRESSION-CREEP TESTS AT HIGH TEMPERATURES.*

By A. E. JOHNSON, D.Sc., M.Sc.(Tech.), M.I.Mech.E., and N. E. FROST, B.Sc., A.M.I.Mech.E.

IN recent years, the need has become apparent for a machine capable of carrying out compression-creep tests at high temperatures, with a precision similar to that normally obtained in a tensile-creep machine under corresponding conditions. A variety of reasons give rise to this need, prominent among them being the need for information concerning the relative characteristics of compressive and tensile creep in the more advanced stages of creep tests, including tertiary creep and creep at fracture. Furthermore, in many instances, a compressive-creep test may be more convenient to make than a tensile-creep test, particularly if only limited quantities of the material to be tested are available, since a considerably smaller specimen is normally required.

The latter factor prompted the design of a compressive-creep machine some years ago in the Metallurgy Division of the National Physical Laboratory, Teddington, and that machine was subsequently developed in the Fulmer Research Institute. Machines of this type were used to test very small quantities of relatively rare alloys, the specimens being only 0·25 in. in gauge length and 0·125 in. in diameter. The strain in the specimen was measured externally to the furnace by means of a multiplying lever and dial gauges, various compensating devices being incorporated in the machine to eliminate expansion errors. Such a machine could not give a high accuracy of measurement of strain. It was felt, therefore, that the design of equipment capable of carrying out a compression-creep test (over a reasonably wide temperature range) with refinements of temperature control and strain measurement corresponding to that obtained in the normal "high sensitivity" tensile-creep test was very desirable, and this article describes such equipment.

The equipment has been designed to be accommodated between the loading shackles of a standard 5-ton Denison creep machine, the only modification necessary to the machine being the removal of the furnace and furnace rods normally used in tensile-creep tests. The existing double-lever loading system of the machine is used to apply the load and, with this system, loads up to 5 tons can be applied to the specimen in increments of 0·001 ton.

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* Communication received from the Mechanical Engineering Research Laboratory, Department of Industrial and Scientific Research, East Kilbride, Glasgow.

COMPRESSION-CREEP TEST MACHINE.

Fig. 4. COMPRESSION STRESS-STRAIN CURVE OBTAINED FROM SHORT-TIME COMPRESSION TEST.

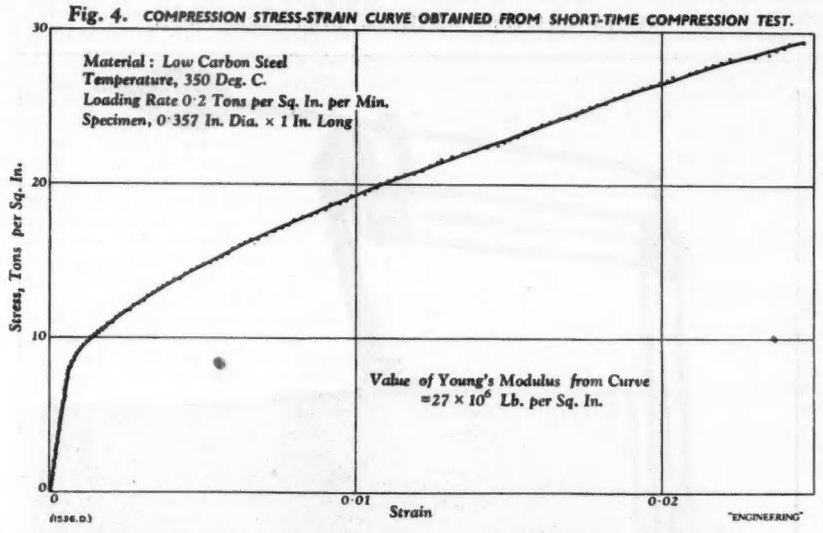
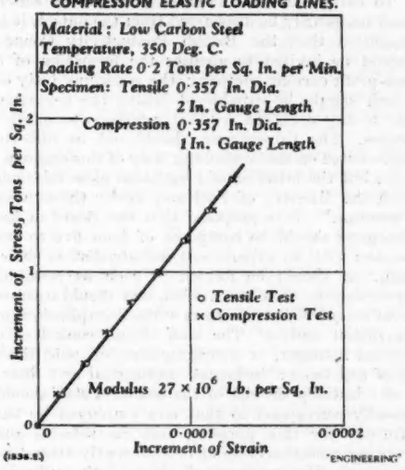


Fig. 5. COMPARISON OF TENSILE AND COMPRESSION ELASTIC LOADING LINES.



The general arrangement of the equipment is shown in Fig. 1, opposite, the overall dimensions being roughly 12 in. wide and 39 in. long. A heavy upper framework, comprising an axial loading guide for upper and lower specimen adaptors, is supported from the upper shackle of the machine. This upper framework is machined from a mild-steel slab 2½-in. thick, and incorporates features of design which have been used successfully in past years at the National Physical Laboratory, Teddington, for guide frames required to produce axial loading in compression. The lower framework, which is purely and simply a loading shackle, consists of two relatively heavy-sectioned mild-steel cross-pieces connected by two 1¼-in. diameter bars of the same material. Both these two frameworks can be rotated quite easily in the shackles of the Denison machine and also relative to each other. During a test, the two frameworks are set approximately at right angles to each other to give a maximum field of illumination to the extensometer mirrors. All the parts of the machine which are situated inside the furnace, including the extensometer limbs, are made from Nimonic 80, any other parts being made in stainless steel. The load is applied to the specimen through a loading spindle which can slide freely through the close clearance hole bored in the top framework, which is prevented from rotating by a key and keyway. To ensure that the lower framework can exert no sideways thrust on the spindle, so ensuring axial loading, the load is transmitted from the upper cross-member of the lower framework to the spindle by a hardened steel ball.

Details of the standard specimen, the specimen seatings and supports and the extensometer are shown in Fig. 2, opposite. The standard specimen is 0·357 in. in diameter by 1 in. long, but, by means of extra attachments which can be added to the extensometer limbs, specimens up to 2 in. long can be tested if required. The size of the specimen has been largely dictated by the necessity of making tests on material taken from locations of a limited size, e.g., specimens trepanned from a gas-turbine disc. In machining the specimen, great care must be taken to ensure that the ends of the specimen are exactly square to the length. Limitations on the diameter of the specimen are imposed since, if too small, buckling will occur, and if too large, non-corrected end effects, due to the increased load required, will become a serious factor. The lower seating for the specimen is a flat surface marked with cross-lines and concentric circles so that the specimen can be easily located centrally. The load is applied to the top of the specimen through a Stellite spherical seating, as shown in Fig. 2, opposite. No special features have been incorporated in the design to prevent the restriction of lateral movement at the ends of the specimen due to the frictional forces between the ends and the seatings; in an actual test, however, graphite is applied liberally to the specimen ends in order to reduce the friction as much as possible.

Carried between the loading spindle and the top spherical seating, the extensometer head has the two outer extensometer limbs rigidly attached to it. The bottom seating is supported on a tubular column which rests on the base of the lower frame, the inner extensometer limb being a continuation of the lower seating and passing through the tubular column. The three extensometer limbs pass through bored holes in the lower frame. Adjustable knife edges are secured to the bottom ends of the two outer extensometer limbs with corresponding fixed knife edges fastened on the central extensometer limb. Rhombs, measuring 0·300 in. across the major axis and carrying the mirrors, are held in place between the knife edges by two light springs. The same optical arrangement of the light source, measuring scale and telescopes as is used in conventional tensile-creep tests is employed to measure the strain in the specimen. Increments of strain of the order of 10^{-6} can be measured.

Due to the relatively small size of the specimen, it is not possible to secure the extensometer directly on to the specimen over a definite pre-determined gauge length. Instead, as already described, the extensometer is fixed to the upper and lower seatings of the specimen. This, however, does not involve any serious error, as any movement of the lower tubular column due to load is transmitted to both the top and bottom extensometers and is thereby cancelled out. Non-compensated errors of movement occur due to compression of the extensometer head, compression of the top spherical seating and compression of that part of the bottom seating between the specimen end and the tubular column. It should be noted that these errors only occur during the loading and unloading of the specimen.

During a creep test, the only movement of the extensometers is due to strain in the specimen, as the end fixings (being made of Nimonic 80) will strain a negligible amount under the much reduced stress in the end fixings as compared with the specimen, at all but the highest temperatures. In view of this, the maximum working temperature for the equipment is taken to be 700 deg. C. The extensometer can be directly calibrated by inserting varying sizes of slip gauges between the upper and lower seatings and observing the corresponding movement of the mirrors.

A cylindrical electric furnace, capable of attaining the maximum working temperature of 700 deg. C., surrounds the specimen, as shown in Fig. 1. For easy assembly, the furnace is made in two halves, being split longitudinally across a diameter of the furnace. When in position, the two halves are clamped together by plates at the top and bottom. The furnace can slide freely on the two round bars of the lower frame and can be locked in any position by means of stops. The furnace winding is tapped at two points to facilitate adjustment of the specimen gradient. The temperature of the furnace is controlled by means of a thermostat nominally maintaining the temperature to within $\pm \frac{1}{2}$ deg. C., and actuated by a platinum resistance inside the furnace. The position of this resistance is shown in Fig. 1. The temperature of the specimen is measured by means of thermocouples, which are tied to the specimen at the middle and as near to the top and bottom of the specimen as possible. The temperature gradient indicated by these couples is usually of the order of 2 deg. C.

In Fig. 3, opposite, is shown a creep strain-time curve of a low-carbon steel at 350 deg. C. It will be noted that the features of this curve are similar to those normally associated with the primary and secondary stages of a tensile-creep test. Apart from its use in compression-creep tests, the machine can be used to conduct short-time incremental compression tests. A curve obtained in such a test on the same low-carbon steel, also at 350 deg. C., is shown in Fig. 4, herewith. The modulus obtained was identical to that obtained in a tensile test of short duration under the same conditions. The elastic stress-strain plot for the two tests is shown in Fig. 5, above.

INDUSTRIAL FUEL EFFICIENCY ORGANISATION.

AMONG the recommendations of the Committee on National Policy for the Use of Fuel and Power Resources (the Ridley Committee) was one that an organisation should be set up to provide increased fuel efficiency advisory services for industry. A Committee was therefore appointed by the Minister of Fuel and Power, under the chairmanship of Sir Harry Pilkington, to work out a scheme for this purpose, and has now prepared a report to which reference was made in the House of Commons on Monday, June 22. It is understood that this report will not be published in the usual way, but we have been provided with a copy, of which a summary is given below.

It is recommended in the report that an industrial organisation should be set up to provide advice to industry on efficiency and economy in the use of all forms of fuel, heat and power; to give practical help in securing the efficient and economical use of fuel and power to industrial fuel users, as well as to others who are not catered for by the Coal Utilisation Council's activities in the domestic field; and to make quantitative heat and power surveys for industrial fuel users. It is also recommended that this body should work in co-operation with other interested associations, should promote research and development in fuel efficiency

engage in publicity, provide advice on measures to abate the smoke nuisance, and promote the training and employment of fuel technologists and boiler-house and supervisory staff at all levels.

To carry out these functions, not all of which need necessarily be discharged from the outset, it is suggested that the British Productivity Council should be invited to sponsor the formation of a non-profit earning company, the governing body of which should be capable of taking the necessary day-to-day decisions without reference to outside bodies. The Government should not be directly represented on the controlling body of this organisation, but the latter should maintain close relations with the Ministry of Fuel and Power through an "assessor." It is proposed that the Board of the Company should be composed of from five to ten persons with an experienced industrialist as chairman. It should be formed as soon as possible, preferably by October 1, 1953, and should operate from a central headquarters without duplication in provincial centres. The staff should consist of a general manager, or managing director, with three chief assistants: technical, commercial and financial. Initially the size of the technical staff should broadly correspond to that now employed by the Ministry for this purpose, and the salaries and working conditions should be sufficiently attractive to secure the services of those with sufficient experience.

It would possibly cost the organisation about 350,000*l.* per annum to carry out the services on the scale of the Ministry's present operations and at least 500,000*l.* per annum when the work is fully established. The source of the required income should be such as to ensure complete independence. It should not therefore be provided by the Government, although the Government should transfer to the organisation free of charge any items of capital equipment that are now used for the Ministry's industrial fuel efficiency work. As it is regarded as impossible to obtain anything like the required sum by voluntary contributions and to expect fees for some of the direct services to cover more than half these costs, it is considered that the proper source of the organisation's income should be an assured contribution from consumers, other than domestic consumers, on the grounds that, with the present and prospective conditions of supply, fuel saving achieved by any industry or firm will in time of shortage be to the advantage of all. The national economy as a whole will also benefit, if fuel is saved and additional coal is made available for export.

A levy on industrial coal is favoured as the means of obtaining contributions, although it is understood that there are objections to this course. If, however, the organisation's finance were provided by the producers of fuel the cost would be borne mainly by consumers. It is therefore hoped that arrangements will be made for adequate financial support from the producers of coal, gas and electricity, together with some voluntary contributions from individual industrial concerns and trade associations.

It is believed that the new organisation will work with the largest coal consumers mainly by direct contact, but as regards the smaller consumers, and generally so far as stimulation of interest in fuel efficiency is concerned, it is recommended it should collaborate with trade associations, industrial research associations and other bodies operating in this field. In particular, it is regarded as of the greatest importance that the work of the new organisation and of the British Coal Utilisation Research Association should be complementary.

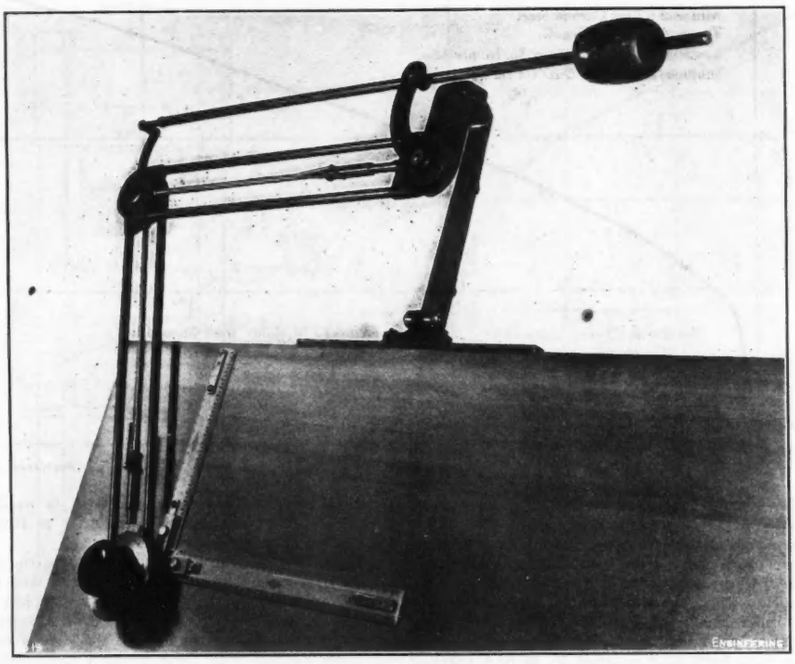
In conclusion, the Committee are satisfied that an increase in fuel efficiency can be obtained by proper education, training and instruction. Savings of the order of 9 million tons per annum, which are indicated by the industrial fuel efficiency service of the Ministry of Fuel and Power, can, however, only be obtained by considerable capital expenditure by individual firms. Industrial firms have no special inducement to spend money in this way, since fuel forms a very small proportion of these total production costs. The necessary incentive should therefore be provided by offering loans to finance fuel saving schemes at specially favourable interest rates and with minimum formality. Further, these loans should be repayable over the period during which the equipment is written off for taxation purposes under the standard Inland Revenue schedules, subject to an overriding maximum period of 20 years. The fuel saving schemes which would be eligible for these incentives should be selected from those of which the initial cost would be recovered from gross savings in fuel cost in not more than seven years.

In this connection it may be recorded that during the discussion on the Finance Bill on Tuesday, June 16, the Chancellor of the Exchequer (Mr. R. A. Butler) announced modifications in the methods of allotting loans in order to encourage the installation of industrial fuel saving equipment. This encouragement would take the form of extending the categories of equipment which are eligible for assistance and of increasing the period during which loans are repayable to a maximum of 20 years. These loans would also be interest-free during the first two years after the equipment has been installed. A leaflet giving full details on this subject will shortly be available from the Ministry of Fuel and Power and, although building licences will be necessary, they will be readily obtainable. The financial transactions involved will be dealt with by the Industrial and Commercial Finance Corporation, Limited.

In a written reply to a question on Monday, June 22, the Minister of Fuel and Power (Mr. Geoffrey Lloyd) said that he had completed his discussions with the appropriate representatives of industry and that the Government accepted in principle the recommendations of the Pilkington Committee given above. He added that the British Productivity Council had accepted the responsibility for forming and sponsoring a fuel efficiency company on the lines recommended in the report and that he had asked them to ensure that its board was as representative as possible of all appropriate interests. The company had been guaranteed contributions for an initial period of five years from the National Coal Board, the British Electricity Authority and the Gas Council; and these would be supplemented by fees and, he hoped, by voluntary contributions. The Ministry's industrial advisory services would cease to function as soon as the new company established its own. He proposed to appoint one of his officials as assessor.

DRAFTING MACHINE.

MAVITTA DRAFTING MACHINES, LTD., BIRMINGHAM.



DRAFTING MACHINE.

THE accompanying illustration shows a new drafting machine to, be known as the "Master," which is now being made by Mavitta Drafting Machines, Limited, Highlands-road, Shirley, Birmingham. The basic model is made for use on a horizontal board to which it can be fixed by either a quick-release clamp or by the screwed anchor casting shown in the illustration; the counter-balance attachment is available for use when the machine is to be attached to an inclined board. The lengths of the arms of the mechanisms are such that the machine is suitable for use on boards varying in size from 42 in. by 28 in. to 84 in. by 44 in.

An unusual feature of the machine, in which it differs from the more conventional types at present in use, is that the link mechanisms are made by endless steel bands passing round pulleys mounted on ball bearings. The bands are protected from damage by locating them in the rigid tubular framing of the machine arms. The automatic location control is provided by a press button contained in the knob of the index head. A vernier scale is fitted to the index plate, which is graduated in degrees, but positive locking of the scales is provided at every 15 deg. and free rotation of the index plate is obtained by depressing the quick-release lever mounted on the head. The scales are divided according to the requirements of the customer and can be supplied in various materials, including white Perspex or transparent Perspex (divided on the underside); boxwood with celluloid edges; or aluminium alloy, anodised black, with white edges.

AUTOMATIC CONTROL OF INTERIOR LIGHTING.—A photo-electric device designed by Radiovisor Parent, Ltd., 1, Stanhope-street, London, N.W.1, for the automatic control of interior lighting, incorporates a time delay which prevents it from being operated until changed conditions have persisted for about 5 minutes. It thus eliminates the "hunting" which may be caused by the passage of clouds. The unit switches on when natural daylight falls to a predetermined level and switches off when it again increases to a pre-set value. Adjustment of these two operations can be effected independently.

TRIALS OF SUBMARINE POWER CABLES BETWEEN FRANCE AND ENGLAND.

IT will be recalled that in 1949 a joint committee of the British Electricity Authority and Electricité de France was set up to study the practicability and economics of effecting a connection between the electric-power systems of these two bodies. The committee reported that a *prima facie* case for such a cross-channel connection had been made out, but that detailed development work, involving considerable expenditure, would be necessary before a final recommendation could be made. An interim report embodying these views was therefore submitted to the British Electricity Authority and Electricité de France in June, 1952, and, as a result, both authorities decided that the proposed development programme should proceed, the cost being shared equally between the parties. This course was subsequently approved by the British Government.

The main project, as envisaged by the joint committee, comprises a 132-kV cable circuit, which would be laid approximately between Dover and Calais and be connected to the British 132-kV system at one end and to the French 90-kV and 225-kV systems at the other. Three single-core cables would be laid, with possibly a fourth as spare. The shortest route length would be about 26 miles; in selecting it consideration would have to be given to the fact that the maximum depth of water in the Straits of Dover is 240 ft., although there are places where it is relatively shallow, owing to the presence of banks. Care would also have to be taken to avoid sunken vessels and communication circuits. Further, the design of the cable presented special problems as the cable might be subjected to severe handling during laying and might subsequently be damaged by anchors. Joints, too, would not be accessible for fault location and repairs would be difficult and costly.

Taking all these factors into consideration, it was decided that the development programme should include the construction of sample joints and lengths of cable, which would be electrically and mechanically proved at the manufacturer's works; that trial installations should be laid at sea, and that these should involve the preparation, laying, dielectric testing, artificial loading and repair and recovery of jointed lengths of cable; that the route should be surveyed to determine the position of the cable as laid; that methods of laying and repairing the cable under working conditions should be investigated; and that means of locating possible gas leaks and of grappling the cable to raise it should be determined.

At present, the possibilities of using both the external gas-compression cable and the pre-impregnated gas-pressure cable are being investigated; the former owing to its high inherent electric strength and the apparent extra security provided by its two lead sheaths, and the latter owing to its simplicity and the possibility of manufacturing it in long lengths. In this country, attention has been concentrated mainly on the pre-impregnated gas-pressure cable and, in particular, on the manufacture of sample suitably armoured lengths, of flexible joints with a diameter not exceeding that of the cable proper, and of rigid joints suitable for expeditious repair at sea. In France, similar work is being undertaken on two designs of external compression cable and two designs of pre-impregnated pressure cable. In addition, Electricité de France are to carry out severe mechanical and electrical tests on lengths of both types of cable, as well as on joints, at their Fontenay Research Centre. Samples of each type of cable, about 125 yards long, will be connected direct to the French 225-kV system and subjected to long-duration stability tests under artificial loading cycles.

CABLE-LAYING ARRANGEMENTS.

It is also of interest to learn that the Post Office cable-laying ship Alert will lay two half-mile lengths of cable of British manufacture off the south coast of England, near Dover, during the present summer. These lengths will be jointed at sea to a 300-yard length of French cable and, after certain electrical tests, both cables and joints will be recovered and returned to the works to discover whether and to what extent they have been damaged during laying. In addition, the French authorities are to carry out a sea trial of two to four 100-yard lengths of gas-compression cable. These cables will be laid off a jetty in deep water and jointed to form a loop. Loading-cycle and direct-current tests will then be made and investigations will be undertaken to study the practicability and sensitivity of different methods of locating a gas fault which has been made artificially at a known point. It may also be possible to test the maintenance of gas pressure and the penetration of sea water into the insulation under fault conditions. It is hoped that all these tests will be completed early in 1954.

Tests on both the British and French systems are also to be made to assess the effect of frequency control, as this will have an important bearing on the security of operation. Day-to-day operational information is already being exchanged between Electricité de France and the British Electricity Authority to study the potential economic transfers of power and the savings in costs that might result. The way will thus be prepared for the preparation of a report on the main project, the contents of which will be awaited with interest.

TRADE PUBLICATIONS.

Lightweight Telephone and Signalling Cables.—British Insulated Callender's Cables, Ltd., Bloomsbury-street, London, W.C.1, have published a leaflet dealing with the lightweight telephone and signalling cables they manufacture for use in mines.

Light-Alloy Vehicle Bodies.—The Northern Aluminium Co., Ltd., Bush House, Aldwych, London, W.C.2, have published "Pantechnicon and Box-Van Designs," No. 3 in their illustrated series of booklets describing the use of light-alloys for road-haulage vehicles.

Oil-Mill Machinery.—We have received from Rose, Downs and Thompson, Ltd., Kingston-upon-Hull, two copies of an illustrated leaflet, one in English and French, the other in English and Spanish, describing the company's products for the edible and fatty-oil industries.

Bulk Cement and Concrete Transportation, Storage and Mixing Equipment.—We have received from Thos. W. Ward, Limited, Sheffield, a brochure describing their pressure-discharging hopper units for the transport of bulk cement and their concrete mixers which mix *en route*, as fitted to proprietary motor chassis and trailers; also described are their cement batching plants and pressure-loading storage hopper.

Mounting Plates for Switches.—J. A. Crabtree & Co., Ltd., Lincoln Works, Walsall, have sent us a leaflet containing particulars of the mounting plates they manufacture for 5-amp. and 15-amp. flush switches, switched socket outlets and indicator units.

Gear-Reduction Motor Units.—We have received an illustrated leaflet from the Motor Gear and Engineering Co., Ltd., Essex and Corona Works, Chadwell Heath, Essex, showing their types A, B, C and D "Motogear" gear-reduction motor units having horse-powers from $\frac{1}{4}$ to 10 and gear ratios from 17 : 1 to 713 : 1.

Overhead Electric Equipment for Mines.—Details of the overhead conductor equipment which they manufacture for electric haulage in mines are given in a recent publication of British Insulated Callender's Cables, Ltd., Bloomsbury-street, London, W.C.1.

Machine Engraving.—Millet, Levens (Engravers) Ltd., Whadcoat-street, Finsbury Park, London, N.4, have produced a catalogue which illustrates some of the many different types of engraving that they undertake. It also gives brief details of their facilities for producing small machine parts.

Electric Vehicles Fitted as Shops.—Austin Crompton Parkinson Electric Vehicles, Ltd., 95-99, Ladbroke-grove, London, W.11, have sent us a leaflet giving a detailed specification of their 20-cwt. and 30-cwt. mobile grocer's shops.

Lubricating Oil.—Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2, have issued a booklet entitled "1952 Shell Successes," containing nearly 100 illustrations of the principal motor-car and motor-cycle sporting events and aeronautical achievements during 1952 in which Shell motor oil was used.

Protective Clothing.—Plysu Products, Ltd., Woburn Sands, Bletchley, Buckinghamshire, have issued an illustrated booklet describing their electronically-welded polyvinyl-chloride protective clothing, for industry and agriculture, in which no stitched seams are employed.

NOTES ON NEW BOOKS.

Prestressed Concrete.

By Y. GUYON, Ingénieur Diplômé de L'Ecole Polytechnique, edited by W. M. JOHNS, M.C., B.Sc., A.M.I.C.E., from the translations of A. J. HARRIS, B.Sc., A.M.I.C.E., J. D. HARRIS, B.Sc., A.M.I.C.E., and T. O. LAZARIDES, Dr.Ing., U.I.Lv. Contractors' Record, Limited, Lennox House, Norfolk-street, W.C.2. [Price 70s. net.]

THIS book, with more than 550 pages and 450 line drawings and photographs, is restricted to statically-determinate straight beams, the subject being dealt with in three parts: Part I is concerned with general considerations, Part II with the elastic design of simply-supported beams, and Part III with tests. Prestressing of concrete is inseparable from the name of Freyssinet, with whom Mr. Guyon was associated for a number of years, and in the foreword Mr. Freyssinet writes "Guyon's book, limited to the study of straight beams on two supports, gives an idea of the number and complexity of the problems met in even such simple structures as these." Part I of the book, after dealing with prestressing methods, plant required, and friction between cable and duct, examines, in detail, anchorage-zone stresses in post-tensioned and pre-tensioned beams, and deduces a means of evaluating stresses in anchorage zones; there are also tables for the calculation of axial stresses, and explanatory worked examples. In Part II the author deals with beams of constant cross-section with uniform steel and with raised cables, a chapter also being devoted to beams of variable depth. The theory is again supported by worked examples. Various tests (some to destruction) are analysed and illustrated in part III. Three appendices deal with the problems of anchorage-zone stresses in rectangular beams, and shear in prestressed and variable-depth beams of different types of section. The book brings together for the first time various scattered information and adds much that is new, particularly the treatment for the evaluation of anchorage-zone stresses.

Farm Power.

By PROFESSOR BEN D. MOSES and PROFESSOR KENNETH R. FROST. John Wiley and Sons, Incorporated, 440, Fourth-avenue, New York 16, U.S.A. [Price 5·75 dols.]; and Chapman and Hall, Limited, 37, Essex-street, Strand, London, W.C.2. [Price 46s. net.]

THIS text-book is written for American students by two American professors of agricultural engineering. It consists of some 450 pages of data (including 285 illustrations) on the construction and operation of internal-combustion engines and, to a lesser extent, farm tractors. Although only American terminology and references are used throughout, and the text lacks balance and clarity in some parts, it is a useful technological volume containing much detailed information. The section on engines commences with fundamental definitions and proceeds almost immediately to engine balancing; the major types of engines and their component parts are then described, only a little familiarity with the subject being assumed. Considerably more space is allotted to spark-ignition than to compression-ignition, and there is, for example, extensive treatment of ignition circuits and carburettors (including butane-fuel equipment). The section on tractors commences with clutches and proceeds to details of transmission systems. Although the treatment is otherwise thorough, and chapters on air-cleaners and spark-arresters are included, insufficient space is devoted to brakes and hydraulic-implement control systems. Maintenance and the economics of operation (on American farms) are discussed at some length but, in general, the authors are concerned with the technicalities of present-day designs rather than with fundamental considerations. For example, the construction of wheels and tracks is described, but the overriding influence of soil characteristics on the operation of these major items is passed over; similarly, details are given of the C.F.R. engine, of dynamometer types and of American test schemes, but little is said about engine or tractor performance. The

book is nevertheless a useful reference work, particularly on engines; it is therefore unfortunate that the title is somewhat misleading. Windmills, water-wheels and—most important of all— distributed electrical power are not covered.

Mechanical Inspection.

By PROFESSOR W. H. ARMSTRONG. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 5.50 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 47*s.*]

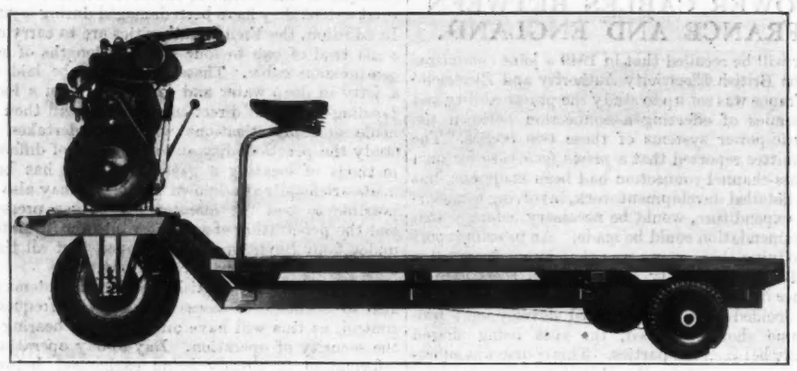
WRITTEN primarily for the technical student or apprentice, this book may well be of interest to anyone who desires a comprehensive survey of the inspection methods available to the modern factory. Beginning with the simple tools and gauges of the workshop, the author goes on to include all types of measuring instruments up to the most precise optical designs needing temperature-controlled rooms for their use. Perhaps more emphasis might have been laid on this need, for all really fine measuring, such as is required frequently to-day, is virtually useless under ambient temperature conditions. The gauges and instruments are accurately described and clear instructions are given for their use. Descriptions are given of comparators, mechanical, electrical and pneumatic types being mentioned, and a section is devoted to optical projection systems. Separate chapters describe the measurement of angles and the checking of screw threads and gears. In the chapters on surface finish and crack detection, all the normal methods are dealt with, but in their American forms. Directly comparable techniques exist, of course, in this country. The final chapter outlines systems of statistical quality control. Although the book is essentially descriptive, all necessary calculations are included, and there are useful questions for revision at the end of each chapter. The visual teaching aids listed in the appendix are, unfortunately, all of American origin. The matter is well presented, though the American conventions occasionally ring unfamiliar to British ears, and the illustrations generally are good.

Electron Tubes in Industry.

By KEITH HENNEY and JAMES D. FAHNESTOCK. Third Edition. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 6 dols.]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 51*s.*]

DEVELOPMENTS in electronic devices, and more especially in their industrial applications, have been so extensive since the previous edition of this book was published 15 years ago that the formidable task of bringing the subject up to date has entailed an almost complete re-writing as well as the omission of some obsolete or unnecessary matter. Both the authors are on the editorial staff of the American periodical *Electronics*, and consequently have at their disposal abundant and often original material from which to select information, with critical regard to the needs of industrial engineers and technicians who are not, primarily, specialists in electronics. Due attention has accordingly been paid, in the opening chapters, to the elements of electric supply and measuring circuits, before the characteristics of all the principal types of electron tubes are examined. Circuits appropriate to a wide field of electronic methods of measurement and control comprise the main body of the book, and are exemplified in relation to a corresponding variety of industrial applications ranging from motor control and high-frequency heating to photo-electric devices and electronic counters. Where the procedures discussed embody tried and tested combinations of equipment that have already found successful applications, sufficient information is given to enable the industrial technologist to evaluate them for specific purposes or adapt them to new problems. Elsewhere the authors are careful to emphasise those aspects of electronic circuitry which contemporary experience suggests are likely to become increasingly important for industrial use. The resulting text, clear, succinct, fully documented and well illustrated, is an admirable source of information and reference.

LIGHTWEIGHT MOTOR TRUCK.



BOOKS RECEIVED.

Energy in Overseas Territories: In Africa South of the Sahara and in Surinam. Organisation for European Economic Co-operation, 2, Rue André-Pascal, Paris (16e). [Price 200 francs.]

Burma. Review of Commercial Conditions. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 1*s.* net.]

Diamond Technology. Production Methods for Diamond and Gem Stones. By PAUL GRODZINSKI. Second revised and enlarged edition. N.A.G. Press Limited, 226, Latymer-court, Hammersmith, London, W.6. [Price 52*s.* 6*d.* net.]

University of Illinois Engineering Experiment Station. Bulletin No. 406. *An Economic Investigation of Solid Journal Bearing Operation in Freight Service on Two Large Class I Railways.* By PROFESSOR ROY M. WRIGHT and others. [Price 1 dol.] No. 407. *Heat Supplied to I.B.R. Research Home from the Inside Chimney.* By PROFESSORS WARREN S. HARRIS and ROSS J. MARTIN. [Price 50 cents.] No. 408. *Stress Distribution and Strength Condition of Two Rolling Cylinders Pressed Together.* By EUGENE I. RADZIMOVSKY. [Price 50 cents.] No. 409. *An Investigation of the Performance of Six Small Septic Tanks.* By E. ROBERT BAUMANN and PROFESSOR HAROLD BABBITT. [Price 60 cents.] No. 410. *A Multitube Differential Pressure Manometer for Measuring the Average Flow of Fluids in Closed Ducts.* By PROFESSOR GEORGE B. CLARK. [Price 30 cents.] The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

The British Electrical and Allied Industries Research Association. Technical Report No. A/T 137. *An Examination of Self-Supporting Films of Cellulose Triacetate, Cellulose Acetate Butyrate and Polythene.* [Price 10*s.* 6*d.*] No. G/T 270. *Breaking Capacity Tests of 440 V, 150 A, and 75 A Three Phase Contactors.* By H. W. BAXTER and B. HOPWOOD. [Price 15*s.*] No. G/T 276. *Flameproof Electrical Apparatus: Flanged Joints, One Half-Inch in Radial Breadth, in Mixtures of Ethylene and Air.* By H. ROBINSON, J. T. W. ROPER and H. L. WILLIAMS. [Price 7*s.* 6*d.*] No. G/T 277. *Flameproof Electrical Apparatus: Flanged Joints, One Half-Inch in Radial Breadth, in Mixtures of Ethyl Ether Vapour and Air.* By H. ROBINSON, J. T. W. ROPER and N. SIMPSON. [Price 10*s.* 6*d.*] No. V/T 108. *Detection of Incipient Failure of Insulation by Observations of Non-Linearity.* By DR. G. MOLE. [Price 24*s.*] No. V/T 115. *Design and Performance of a Portable A.C. Discharge Detector.* By DR. G. MOLE. [Price 15*s.*] Offices of the Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.

The College of Aeronautics, Cranfield. Report No. 63. *Strain Energy Analysis of Swept Boxes with Ribs Normal to the Spars.* By D. HOWE. No. 73. *The Calculation of the Profile Drag of Aerofoils and Bodies of Revolution at Supersonic Speeds.* By A. D. YOUNG. No. 74. *The Numerical Solution of Certain Differential Equations Occurring in Crocco's Theory of the Laminar Boundary Layer.* By DR. S. KIRKBY and T. NONWEILER. The Librarian, The College of Aeronautics, Cranfield, Bletchley, Buckinghamshire. [Price 5*s.* each.]

Corrosion. A Series of Papers Reprinted from *Research*, vol. 5, 1952. Butterworths Scientific Publications, 88, Kingsway, London, W.C.2. [Price 6*s.* net.]

Schriftenreihe Antriebstechnik. No. 10. *Versuche an Zylinderschneckentrieben: Einfluss von Zahnform, Modul, Durchmesser und Schmierstoff auf Verlustleistung und Tragfähigkeit.* [Price 18.80 D.M.] No. 11. *Formänderung und Profilrücknahme bei gerad-und schrägverzahnten Rädern.* [Price 13.80 D.M.] Friedrich Viewng und Sohn, Braunschweig, Germany.

LIGHTWEIGHT MOTOR TRUCK.

THE lightweight motor truck shown in the accompanying illustration will transport a recommended tare load of 1 ton, carried on a low-level platform 5 ft. 9 in. long by 3 ft. 2 in. wide. This new truck, the "Pyramid," which is made by the Excelsior Motor Company, Limited, Kings-road, Tyseley, Birmingham, 11, has a turning circle of 72 in., so enabling it to be manœuvred into very restricted areas.

The power unit, made by the Villiers Engineering Company, Limited, Marston-road, Wolverhampton, is a four-stroke air-cooled petrol engine of 1¼ h.p., with a built-in magneto on the flywheel. The engine is started by spinning the flywheel by a rope wound on to a pulley mounted on the flywheel shaft. Splash lubrication from a large-capacity sump in the crankcase is employed. The three-speed gearbox is made by the Albion Engineering Company, Limited, Upper Highgate-street, Birmingham, 12, and has a built-in clutch controlled from the driving handle by a cable and ratcher lever. Roller-chain transmissions are used between the engine and the gearbox and between the gearbox and the wheel sprocket, which is built into the front-wheel assembly. For ease of maintenance, the engine, gearbox, transmission turntable, driving wheel and front brake system have been assembled as a single unit which can be freed from the main chassis by removing four nuts and bolts.

The steering is controlled by the hinged tubular handle, which can be swung either backwards or forwards over the engine. As the turntable permits the front wheel to be rotated through the full circle, the driver can employ the three gears for both forward and reverse travel. The petrol consumption is approximately ¼ pint per hour under normal working conditions, and the tank has a capacity of four pints, that is, roughly the consumption required for a single working shift. The safe maximum speeds in first, second and third gear are 1, 3 and 6 m.p.h., respectively. A 16-in. by 4-in. heavy-duty pneumatic tyre is fitted to the front wheel and 10-in. by 4-in. tyres on the rear wheels, all three wheels being fabricated from steel pressings. On the standard model, brakes are fitted only to the front wheel, where internally-expanding taper-wedge linings are used inside a 6-in. diameter drum. The brakes are controlled by a hand lever fitted with a ratchet for holding the truck in a parking position. Where extra-heavy loading is expected, brakes operated by a foot pedal and cables can be fitted to the rear wheels.

EXPERIMENTAL WASTE-COAL POWER STATION.—The British Electricity Authority have received the consent of the Ministry of Fuel and Power to build a new power station at Ochiltree, Cumnock, Ayrshire. It will be known as the Barony power station and will be designed to burn slurries and filter cake from adjacent coal washeries, the great bulk of which has hitherto been little used. In this way the Authority will further assist the release of better quality coal for export and other purposes. The plant will consist of four 150,000-lb. boilers, two 30-MW turbo-alternators and two 1,500,000-gallon cooling-towers.